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PRELIMINARY ENGINEERING REPORT

ON

PROPOSED ALBERTA-MONTREAL CRUDE OIL PIPELINE

PREPARED FOR

HOME OIL COMPANY LIMITED

BY

DUTTON-WILLIAMS BROTHERS LIMITED

ENGINEERS - CONSTRUCTORS

CALGARY, ALBERTA

VOLUME II

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February 26, 1958

VOLUME II

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CONSTRUCTION SPECIFICATIONS

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SECTION 2.00: DEFINITIONS

2.01 The term "Company" shall mean the owner of the Alberta-Montreal crude oil pipeline.

2.02 The word "Contractor" shall mean the party or parties contracting to perform the work herein described.

2.03 The word "Engineer" shall mean the field representative of the Company.

2.04 The term "Right-of-Way", unless otherwise defined, shall mean a strip of land as acquired by the Company and marked by survey monuments, stakes and other markers, and on which the pipeline is to be laid.

2.05 The word "Work" shall mean the work specified herein and as indicated in the plans and drawings, more specifically described in the construction contract.

GENERAL CONDITIONS

SECTION 50.00: METHOD OF PERFORMANCE

50.01 It is specifically understood that Contractor is an independent Contractor and that the Work to be performed hereunder shall be carried on by the Contractor according to its own methods and at its own risk subject only to compliance by the Contractor with the provisions of the Contract Documents. Contractor shall have full legal charge and control of Contractor's men engaged in the performance of the Work hereunder and Contractor shall be accountable to Company in no respect for the method of performance, but only for prosecution and completion of the Work provided for herein in accordance with the provisions of the Contract.

50.02 Contractor shall do no work except during daylight hours without consent of Company, except in completion of treacherous or dangerous sections of work, delay of which might result in unreasonable loss or damage to property.

SECTION 51.00: AUTHORIZED REPRESENTATIVES

51.01 The Company's "Authorized Representatives" shall be the Engineer who shall be designated in writing by Company to Contractor, the Chief Inspector who shall be designated in writing by Company to Contractor, and such other representatives as shall be designated in writing by Company to Contractor.

51.02 The Engineer, so appointed, shall be charged with the duty of ascertaining that the Work is done in accordance with the provisions of the Plans, Specifications, and the other Contract Documents. He shall have the authority to reject all work and materials which do not conform to the Contract Documents, and shall have such other authorities as are conferred upon him in the Contract Documents.

51.03 The Company, in lieu of the designation of the "Engineer", may designate in writing some other "Authorized Representative" who may perform the duties and exercise the authorities conferred on the Engineer by the Contract Documents.

51.04 The Inspector or Inspectors shall have the right and duties and shall perform the functions provided in Section 58.00 of these General Conditions.

51.05 Contractor's "Authorized Representative" shall be Contractor's Superintendent, Foreman, or other in authority, which representative or representatives shall be designated in writing by Contractor to Company.

SECTION 52.00: MATERIAL AND EQUIPMENT

52.01 When it becomes necessary to store pipe at delivery points, the Contractor shall unload and store pipe at no additional cost to Company.

52.02 All Company property lost, damaged, injured or stolen, after being received by Contractor, or after delivery for account of Contractor in railroad cars or at unloading points, shall be replaced by Contractor with like kind and at no expense to Company; and all demurrage and storage charges will be borne by Contractor.

52.03 The Contractor shall promptly repair all bridges, roads, fences, buildings or other property damaged by him in the progress of the Work.

The Contractor shall hold Company harmless from all claims for injury to persons or property damage caused by the Contractor in the work of loading, hauling, and unloading construction supplies, material and equipment.

52.04 All losses incurred by abnormal wastage, by injury or damages and losses suffered by reason of theft, robbery or otherwise to or of pipe, pipe fittings, or other material, whether furnished by Contractor or Company (after materials furnished by Company have been delivered to Contractor), shall be borne by Contractor. Pipe ends damaged by careless handling shall be re-cut and beveled at Contractor's expense.

52.05 Contractor shall furnish all equipment required for the performance of the Work in the time specified in these Contract Documents, and such equipment shall be serviceable and shall be kept in first class operating condition. In the event any of such equipment shall break down and/or become unserviceable, Contractor shall immediately repair or replace the same with serviceable equipment in order that the Work to be performed by Contractor hereunder shall be of a high standard of quality and in order that the progress of the Work shall not be interrupted.

52.06 All material and equipment furnished by Contractor must be satisfactory to the Engineer; any material or equipment that is not satisfactory shall be removed by Contractor and satisfactory equipment or material substituted therefor.

SECTION 53.00: CHECK OF MATERIALS

53.01 All pipe and other material furnished by Company shall be checked for quantity and condition by both Company and the Contractor and this record shall determine the amount of material delivered to the Contractor by Company. The Contractor shall be responsible for all material after same has been delivered to its representative and the lack of check or inspection by the Contractor will not relieve it of responsibility for the replacement of lost, stolen or damaged material without added cost to Company.

SECTION 54.00: CHANGES AND EXTRA WORK

54.01 The Company shall have the right, at any time, to make such changes in the Work (as the Work is specified and described in the Contract Documents) as it shall deem necessary or advisable.

54.02 No change in the Work shall be made unless authorized by a written "Change Order", issued prior to the doing of any work in connection therewith, which change order must be in writing signed or countersigned by the Engineer and delivered to Contractor's authorized representative.

54.03 The Company may at any time, by such change orders, issue additional instructions, make changes in the Specifications and Plans, omit certain work and require additional work to be performed by Contractor. In any such event Company shall specify in the change order the amount and kind of work to be done or omitted. No such change order shall be valid or effective unless signed or countersigned by the Engineer.

54.04 Contractor shall make no additions, changes, alterations, or omissions, perform no extra work nor supply or use extra material or equipment of any kind (for which he claims or expects to claim additional payment under the provisions of Section 55.00 of these General Conditions) except upon a prior written change order signed or countersigned by the Engineer, and Contractor shall receive no compensation for extra work

not so authorized. No one except an executive officer of Company shall be authorized to waive this requirement, which waiver shall only be in writing. No specific waiver of this requirement or any number of specific waivers thereof shall be held to constitute a waiver of this requirement, nor to waive the necessity that subsequent changes in the Work must be authorized by prior written change orders.

SECTION 55.00: PAYMENT FOR CHANGES AND EXTRA WORK

55.01 No bill or claim for extra work, extra materials, extra equipment or any changes in the Work involving extra cost shall be allowed or paid unless the performance thereof shall have been authorized in writing by the Engineer prior to the doing of such extra work. Should any change or extra work properly authorized be of such nature that no unit prices listed in the Contractual Agreement apply to same, then the amount of payment or basis of payment shall be determined and agreed upon in writing by the Engineer and Contractor's authorized representative prior to the commencement of the Work contemplated by such order, and such agreed payment or basis of payment shall be set out in the change order. In no event, however, shall the cost of any extra work required hereunder be in excess of the following:

(a) The Contractor's actual cost for direct labour, materials furnished, taxes, insurance and the cost agreed upon at the inception of the Contract for equipment use or rental (except that if the extra work entails the use of extra equipment not already on the job, then the actual cost to Contractor of procuring and using such equipment for the performance of the extra work) plus,

(b) A percentage stipulated in the Contractual Agreement, of the actual cost for direct labour, which percentage shall include Contractor's profit, general supervision, overhead costs, and all costs not listed in (a) next above.

55.02 Contractor agrees to furnish all superintendents, labour, tools, and equipment required to perform the extra work, and shall do and complete same in an expeditious and workmanlike manner, to the satisfaction of the Engineer.

55.03 To obtain payment for extra work, the Contractor shall submit a detailed statement of all extra work performed by Contractor together with satisfactory evidence of payment of all indebtedness arising in

connection therewith. Such statement of extra work shall be approved by the Engineer before submission by Contractor for payment.

55.04 The Company reserves the right to check the labour and equipment time included in the changes provided for hereunder by the use of time checkers and equipment checkers as Company may deem necessary. In the event Company exercises this right, Contractor shall furnish and make available to such time checkers and equipment checkers complete information and records relating to such labour and equipment time.

55.05 No one except an executive officer of Company shall be authorized to waive any provision of this Section 55.00, which waiver shall only be in writing. No waiver of any violation of any provisions of this Section 55.00, or any number of waivers of violation thereof, shall be held to constitute a waiver of any subsequent violation thereof, nor waive the necessity for subsequent compliance therewith.

SECTION 56.00: RIGHT-OF-WAY AND CONDUCT OF WORK THEREON

56.01 The Company reserves the right to make any changes deemed by it necessary in the pipeline survey. Such changes shall in no way alter the Contractor's obligations under the Contract Documents.

56.02 In clearing the right-of way and in the performance of the Work, Contractor shall give due consideration to the interests and property of landowners and tenants wherever involved and shall carry out and perform its work in a manner which shall cause the minimum of inconvenience, injury or damage. The Company will furnish Contractor information concerning easements and other permits acquired by Company for right-of-way purposes which includes special restrictions and provisions contained therein. Contractor shall familiarize itself with such easements and permits and shall be held responsible for compliance with all requirements thereof. Contractor shall restore all damaged property to as near its original conditon as possible, including, without limitation, buildings, fences, hedges, roads, railroads, bridges, culverts, drainage ditches, drainage tile, levees and other property damaged, occupied, or crossed in said construction. When it is necessary to repair property damaged in the prosecution of the Work, such property shall be put into as good condition as before damage occurred.

56.03 Tractors or any other equipment of Contractor shall not operate over or within five (5) feet of any pipelines, telephone lines, poles or cables (whether the property of the Company or others) without the permission of the Engineer.

56.04 Contractor shall exercise due care in closing gates and fences, repairing fences, guarding open ditches and taking such other measures as necessary to safeguard persons, cattle and other livestock from death or loss or injury incident to the performance of the Work, and Contractor shall be responsible for and shall pay, save harmless, protect and indemnify Company from all claims on account of such damage.

SECTION 57.00: DELAYS AND MOVES-AROUND

57.01 After Work has been commenced, the same shall be continuously and diligently prosecuted by Contractor until completion, and in any event the same shall be completed not later than the completion date, if any, specified in the Contractual Agreement.

57.02 If Contractor or its subcontractors are responsible for a delay in the progress of the Work, Contractor shall, without additional cost to the Company, work such overtime, acquire and use for prosecution of the Work such necessary additional equipment and/or perform such other acts as may be necessary to avoid delay in the final completion of the Work.

57.03 If Contractor is forced to cease all or a portion of his operations due to lack of right-of-way procurement, or delay in pipe delivery, Contractor shall give the Company written notice of such total or partial shutdown, and such shutdown shall not be deemed to have begun earlier than the date of the written notice.

57.04 In the event of a total or partial shutdown for the reasons stated in the next preceding Subsection 57.03, the Company shall pay the Contractor on account thereof an amount equal to the actual field cost of Contractor's spread or spreads, or crew or crews, actually so delayed for the period of such delay; in the event of a total shutdown, such amount shall not exceed, however, the maximum amount allowable for such purpose as provided in the Contractual Agreement. In the event of a partial shutdown for such reasons, Company shall pay to Contractor on account thereof for each calendar day of such shutdown, on account of that portion of each spread so shutdown, the following percentages of said calendar days total cost of a whole spread with respect to the operations which have been so shutdown.

Operation	Shutdown Time Percent of Total Shutdown Price
Clear	10
Grade	10
Ditch	20
Bend and Lay	20
Weld	20
Coat and Wrap	10
Lower-in and Backfill	10

Contractor shall not be entitled to either total or partial shutdown payments if the delay is due to force majeure under the provisions of Section 71.00 of these General Conditions.

57.05 In places where right-of-way has not been obtained, or delay is caused by reason of injunction against Company, or other legal obstacles, or Company is unable to make pipe or other essential materials available, then if written notice shall be given by Company or the Engineer to Contractor, the Contractor shall move his men and equipment away from such place, and on to another point on the pipeline on which he was then engaged, or on to a point on any other pipeline, the construction of which is covered by the Contractual Agreement. The Contractor shall at a later date complete any work so moved away from when requested so to do by Company, such work to be done at the unit prices specified in the Contractual Agreement. Unless otherwise specified in the Contractual Agreement, Company shall pay to Contractor the actual field cost to the Contractor for moves so caused and which would not otherwise have been necessary to complete the Work. Even though Company's inability to obtain pipe or other essential materials is due to no fault of Company, and shall be covered by Section 71.00 of these General Conditions, if Company shall elect to require Contractor to move his men and equipment as provided in this Subsection 57.05, it shall pay the costs of such moving in accordance with the provisions hereof.

57.06 The exact amount due Contractor under the provisions of Subsections 57.04 and 57.05 of this Section 57.00 shall be fixed and determined by Engineer.

SECTION 58.00: INSPECTION

58.01 The Company contemplates and Contractor hereby agrees to a thorough inspection by Company, by any of its authorized representatives, of all the Work performed and materials furnished by Contractor under this Contract, as the Work progresses. All work performed by Contractor and all materials furnished by Contractor hereunder shall be subject to the inspection of inspectors to be designated in writing addressed to Contractor by the Engineer and it is understood that, at Company's election, the Inspectors may use radiographic equipment to aid in the inspection of any part of the Work. Company shall make inspection timely so as not to delay or cause expense to Contractor.

58.02 Contractor shall furnish to the Inspectors and their assistants access at all times to the Work wherever it is in progress, and Contractor shall provide them every reasonable facility for the purpose of inspection. If in the judgment of Company's Inspector any work performed by Contractor or materials furnished by it hereunder are defective, or failed to comply with the Specifications, the Plans or other Contract Documents, then Contractor shall, at its own expense, immediately repair or replace the work and/or materials so found to be defective in a manner complying with said Specifications or Plans and to the satisfaction of Company. The cost of dismantling portions of finished work for purposes of inspection and reassembling same shall be borne by Company if said work and materials are found to be satisfactory, but shall be borne by the Contractor if said work or materials are found to be unsatisfactory.

58.03 If Contractor fails, after reasonable notice, to replace any defective work or materials furnished by Contractor, Engineer and/or Inspector may cause such defective work or materials to be replaced and the expense thereof shall be deducted from the amount to be paid to Contractor.

58.04 Neither the Inspector nor any of his assistants shall have the power to waive any of the provisions or requirements of the Contract Documents or any of the obligations of Contractor including the furnishing by Contractor of good and suitable material and the performance of good work by Contractor as herein prescribed.

58.05 A copy of the Contract Documents shall be in the possession of Company's Inspectors and Contractor's superintendents or foremen at all times while on the job.

58.06 Failure on the part of the Inspectors, Engineers or other agents of Company to discover or reject defective work or materials furnished by Contractor and not in accordance with the Specifications and Plans shall not be construed to imply an acceptance of such work or materials; also no payment, nor partial or entire use of operation of the Work by Company shall be construed to be an acceptance of any work or materials which are not strictly in accordance with the Specifications and the Plans.

SECTION 59.00: CONTRACTOR'S EMPLOYEES

59.01 Contractor shall perform the Work in a workmanlike manner by qualified, competent, careful, and efficient workmen in strict conformity with the Contract Documents. Company shall have the right to require the removal from the Work of any employee of Contractor, or of its subcontractors, who in Company's opinion may be incompetent, careless or not qualified to perform the work assigned to him or who may be otherwise insubordinate or guilty of improper conduct, or who in any manner jeopardizes Company's public relations.

59.02 Contractor shall, so far as practical, employ local labour from the area in which the Work is being performed. Contractor shall handle the employment of labour in such manner as to satisfy the reasonable requirements, with respect to such employment, of public authorities of the communities, or political subdivisions in which the Work is being carried on; provided, however, that the requirements of this paragraph shall apply only to unskilled labour, and shall not be construed to compel the payment of a higher scale of wages than is customary in the territory for the kind of work contemplated hereunder.

59.03 Contractor shall comply with all laws, Dominion, Provincial, State, Federal and local, with respect to the employment and working of its agents, servants, and employees engaged in the Work, and with respect to the payment of wages and compensation thereto.

SECTION 60.00: SUPERINTENDENCE BY CONTRACTOR

60.01 Contractor shall give adequate personal supervision to the Work and shall keep a competent superintendent and competent foreman continuously at the site of the Work.

SECTION 61.00: SUBCONTRACTORS

61.01 Contractor shall procure Company's written approval before subcontracting any portion of the Work and shall obtain Company's written approval of all subcontractors. No such approval shall relieve Contractor from any of the obligations of this Contract to Company. Contractor shall be and remain liable as if no such subcontract had been made or approved by Company. Contractor shall check subcontractor's work in full detail and keep such records and furnish such reports and information relative to subcontractor and subcontractor's work as Company may request.

61.02 The right is reserved by Company to withhold its consent to the making of any subcontract.

61.03 No subcontract shall bind or purport to bind Company, but shall contain provisions permitting assignment thereof to Company.

61.04 Contractor shall be as fully responsible to Company for any act or omission of any person directly or indirectly employed by Contractor, and for any act or omission of any subcontractor or subcontractors and of persons either directly or indirectly employed by such subcontractor or subcontractors, or either of them, as though the act or omission were done by an employee of the Contractor subject to Contractor's direction.

61.05 The Work of any subcontractor shall be subject to inspection by the Engineer and Company's Inspectors to the same extent as the Work of the Contractor, and all subcontracts let by Contractor under the terms hereof shall so provide.

SECTION 62.00: PERMITS AND LICENSES

62.01 Contractor shall procure at its own expense any and all permits and licenses (other than right-of way, railway crossing, highway crossing, river crossing or other crossing permits on the pipeline right-of-way) and fully comply with the laws of all jurisdictions in which the Work is located as may be necessary for the performance of the Work, including without limitation of the foregoing, any and all permits for its use of public highways and including, without limitation, all necessary corporate or other qualifications in the Province in which work hereunder is to be performed and shall conform to all laws, ordinances and regulations of any regulatory body having jurisdiction therein. To the extent that public

roads and highways are not available, ingress and egress to and from the rights-of-way shall be along the rights-of-way themselves or as may be permitted and designated by the landowner on whose land this Work is being performed, it being the duty of Company to obtain all necessary permits or licenses for this purpose from landowners and others. Contractor shall be liable for any and all damage to roads, bridges, or highways caused by it and agrees to pay, indemnify and save harmless Company from any loss or damage sustained by Company due to the damage or alleged damage to roads, bridges, or highways caused or alleged to have been caused by Contractor.

62.02 Public travel shall not be needlessly inconvenienced nor shall it be wholly obstructed at any point without the consent of authorities having jurisdiction nor without the consent of the Engineer. Contractor shall furnish and maintain, where necessary, lanterns, barricades and signs to fully protect the public.

62.03 Contractor shall familiarize itself with all roads, railroads, drainage, levee, and river crossing permits or other permits of such nature procured by Company, and upon Company's request, with any special or unusual requirements of rights-of-way grants, and shall comply with all requirements thereof in any way relative to the conduct of the Work or to restoration of such road or other crossings or to the performance of any other work in connection with or resulting from such construction. Contractor shall notify the proper authorities before starting the installation of any crossing.

SECTION 63.00: PATENTS AND ROYALTIES

63.01 Contractor shall defend all suits or claims against Contractor and/or Company, arising from any infringement, real or claimed, of any patented or unpatented invention, article, machine, appliance, manufacture, structure, composition, arrangement, improvement, design, device, and/or method of process embodied or used in the performance of this Contract, including its use by Company, and hereby agrees to indemnify Company and hold it harmless from liability of any kind or character, including court costs and attorney's fees, in connection with all such suits or claims, provided, however, that nothing herein contained shall apply to any materials furnished by Company to Contractor. Company shall give written notice of all such claims and patent infringements, suits, or claims instituted or asserted against it to Contractor who shall defend same at Contractor's own cost and expense.

63.02 Contractor shall pay all royalties and license fees on the equipment and materials furnished by it.

SECTION 64.00: SOCIAL SECURITY, UNEMPLOYMENT COMPENSATION, WITHHOLDING TAXES

64.01 Contractor assumes full responsibility for and agrees to pay all contributions and taxes payable under all Dominion, Provincial, State or Federal Social Security and Unemployment Compensation Laws, and under all other social and/or protective legislation for the benefit of Contractor's employees and workmen engaged in the performance of the Work hereunder. Contractor also agrees to meet all requirements specified under the rules and regulations of administrative officials or boards charged with the enforcement of the Provincial, Dominion, State or Federal Acts on the subject referred to above.

SECTION 65.00: INJURIES AND DAMAGES

65.01 Contractor shall continuously and adequately protect the Work from damage, and shall protect Company's property from injury or loss arising in connection with this Contract. Contractor shall make good any loss, damage, or injury to the Work or to the owner's property, except such as may be caused directly and proximately by the negligence of Company. Contractor shall adequately protect the property of others at the site of or adjacent to the Work as provided by law and the Contract Documents.

65.02 Contractor shall take all necessary precautions for the safety of the employees on the Work and shall comply with all applicable provisions of Dominion, Provincial, State and local safety laws to prevent accidents or injuries to persons or damage to property on or about or adjacent to the premises where the Work is being performed.

65.03 Contractor assumes entire responsibility and liability and agrees to indemnify and hold harmless Company and its representatives against any damages or claims for damages sustained or alleged to have been sustained in connection with and/or to have arisen out of blasting and other operations of the Contractor in connection with rock excavation.

65.04 Contractor assumes responsibility and liability for, and agrees to indemnify, protect and hold harmless Company and its representatives, from all claims, damages, expenses and liabilities of every kind or character arising out of or alleged to have arisen out of the acts or failure to act of the Contractor, or of its agents or employees, or sustained or alleged to have been sustained in connection with and/or to have arisen out of the performance of the Work by Contractor, its agents, and employees and its subcontractors, their agents and employees, including, without limitation, the following:

(a) All injuries to persons including fatal injuries.

(b) All damages to livestock or damages caused by livestock and claims and demands with respect thereto, including all off right-of-way crop damage and all damages caused as a result of fences, gates, and gaps left open or insecurely closed.

(c) All other damages to property and claims and demands with respect thereto; except that necessary and unavoidable damages to crops, timber and improvements within the confines of the pipeline rights-of-way obtained by Company are to be borne by Company; provided damages to fences within the right-of-way and ways of ingress and egress and all damages and injuries on the right-of-way occasioned by the wrongful act or negligence of Contractor, or its subcontractors, their agents and employees, or damages which were not necessary in the performance of the Work, shall be borne by Contractor.

This Subsection 65.04, including subparagraphs (a), (b) and (c) thereof, shall apply to and be construed to include, but is not limited to injuries or damages occasioned by failure of or use or misuse of any and all kinds of equipment, whether owned or rented by Contractor or furnished by any subcontractor.

65.05 In making settlement of all claims for damage for which the Contractor is liable, the Contractor shall either authorize Company in writing to settle for it or appoint a representative who shall accompany a Company representative to make settlement; releases shall run to Company and also shall provide for the release of all of Contractors and subcontractors of Company. If Contractor fails to appoint and make available a representative to make settlement of such claims after five (5) days written notice, or if Contractor's appointed representative jointly with

Company's representative is unable to make prompt and satisfactory settlement of any such claim (unless Contractor reasonably and in good faith contests the validity or reasonableness of such claim, and it is its intention to litigate the claim involved), then in either of such events, Company reserves the right to make settlement of the claim and to charge the amount paid to Contractor and to deduct same from any amounts due to Contractor under this Contract. The release forms used by Contractor shall be subject to the approval of Company and Company shall be furnished with a copy of all releases obtained. In the event Contractor elects to litigate the amount or validity of any such claims for damages, Company shall have the right to hold, at the time of final settlement from the sums due to Contractor, amounts sufficient in the judgment of Company to cover payment of judgments thereon, together with all court costs, attorneys' fees, and all other items of cost of every kind or character.

65.06 It is further agreed that Contractor shall defend, in the name and on behalf of Company, any and all suits against Company seeking to recover damages on account of any injury, damage, death or destruction caused or alleged to have been caused by any acts or omissions of Contractor on account of which Contractor has hereinabove agreed to hold harmless, protect and indemnify Company, even if such suit is groundless, false or fraudulent, and shall pay any judgment rendered in any such suit, including court costs, and shall also pay the fees of counsel Company shall deem it necessary or desirable to employ in connection therewith. Company shall have the right, if it so elects, to take an active part in the defense of any such suit, and to file intervention or other similar proceedings therein if it deems such action desirable. Contractor shall have the right to make settlement of any such suit as may be deemed expedient by Contractor, provided that if Contractor fails to make settlement of any claim or suit filed within a period of thirty (30) days after notice of such claim or suit has been given to the Contractor by Company, and if Company believes in good faith that the failure to make a satisfactory settlement of such claim or suit will harm Company in its relations with the claimant or others, and so notified Contractor, and if within ten (10) days after such notice Contractor fails to make settlement with such claimant, Company in its discretion may make such settlement as its officials believe reasonable, and Contractor agrees immediately to reimburse Company for the amount so paid in settlement.

SECTION 66.00: INSURANCE

66.01 To protect Company against liability for damage, loss or expense arising from damage to property or injury or death of any person or persons, arising in any way out of, in connection with, or resulting from the Work, Contractor shall provide, before work is commenced hereunder, and shall at all times during the progress of the Work, carry at its own expense, in reliable insurance companies acceptable to Company, and authorized to do business in the Province or State in which the Work is to be performed hereunder, the following minimum insurance coverage:

(a) Workmen's Compensation--in such amounts as to afford protection under the laws of the Province or State in which the Work will be done.

(b) Employer's Liability--Limits $50,000/100,000.

(c) General Public Liability, including Contractor's equipment and teams--Limit $50,000/100,000.

(d) General Property Damage, including Contractor's equipment and teams--Limits $50,000

(e) Property damage insurance shall include broad form property damage covering Contractor's liability for loss of or damage to property arising out of the collapse or of structural injury to any building or structure due to excavation, tunnelling, or to moving, shoring, underpinning, raising or demolition of any building or structure, or removal or rebuilding of any structural support thereof, or from blasting or explosions, nor shall said property damage exclude coverage for injury to or destruction of wires, conduits, pipes, mains, sewers or any other property below the surface of the ground.

(f) Automobile Public Liability, owned, non-owned and hired cars--Limits $100,000/300,000.

(g) Automobile Property Damage, owned, non-owned and hired cars--Limits $25,000.

(h) If aircraft shall be used in connection with Work to be performed under this Contract, Contractor shall carry Aircraft Public Liability and Property Damage Insurance with bodily injury limit of not less than $100,000 for injuries to or death of any non-passenger,

and not less than $300,000 for injuries to or death of more than one non-passenger resulting from any one accident; bodily injury limit of not less than $100,000 for injuries to or death of any one passenger, and not less than $300,000 for injuries to or death of more than one passenger resulting from any one accident; and property damage limit of not less than $25,000 per accident, $100,000 aggregate.

66.02 Before Work is actually commenced, Contractor shall submit to Company at its principal office designated in the Contractual Agreement, certificates evidencing that satisfactory coverages of the types and limits set forth in Subsection 66.01 hereof are in effect. Policies providing for such coverages shall contain provisions that no cancellation or material changes in the policies shall become effective except upon fifteen (15) days written advance notice thereof to Company, and the certificates furnished to Company shall show this fact.

66.03 Neither the providing of insurance by the Contractor in accordance with the requirements hereof nor the insolvency, bankruptcy, nor failure of any insurance company carrying insurance of Contractor, nor the failure of any insurance company to pay any claim accruing shall be held to waive any of the provisions of this Contract with respect to the liability of the Contractor or otherwise.

SECTION 67.00: PAYMENTS OF BILLS

67.01 Contractor shall promptly and satisfactorily pay all bills for and settle all claims for labour and materials incurred by Contractor in connection with the performance of its work hereunder; and shall also promptly pay and discharge all damage claims of every kind which Contractor is obligated to pay under the terms of these General Conditions and the Contract Documents. Contractor shall indemnify and save harmless Company from all claims, demands, causes of action or suits of whatever nature arising out of the services, labour and materials furnished by Contractor or its subcontractors in connection with the Work; and all labourers', materialmens' and mechanics' liens upon the Work or upon the real property upon which the Work is located arising out of the services, labour and materials furnished by Contractor or any of its subcontractors under this Contract; and shall keep said real property and the Work free and clear of all liens, claims and encumbrances arising from the performance of this Contract by Contractor or its subcontractors.

67.02 In the event the Contractor fails or refuses to promptly and satisfactorily settle all such bills and/or claims, Company shall, at its option, and upon notice to Contractor in writing, have the right to settle such bills and/or claims for the account of Contractor and deduct the amount thereof from any amounts due Contractor hereunder; provided, however, that if Contractor reasonably and in good faith contests the validity and reasonableness of any such claims, Contractor shall be under no obligation to pay the same until a compromise settlement with the claimant satisfactory to Contractor is effected or until a final judgment is rendered against Contractor and/or Company on such claim. But until payment by Contractor or final judgment, in the final appellate court, if appeal is or may be taken, Company shall be entitled to withhold from all moneys due under the Contract to Contractor a sum sufficient to cover any judgment which may be rendered, together with all court costs, including cost of appeals, attorney's fees, and other items of estimated cost and expense.

67.03 If required, Contractor shall furnish a good and sufficient release and waiver of lien from itself, every subcontractor, materialman, labourer, and all other persons furnishing services, labour or material in connection with the Work, or receipts in full, together with proper and sufficient affidavits satisfactory to Company to the effect that the receipts cover all the services, labour and materials furnished to Contractor or its subcontractors in connection with the Work, except as covered by the release and waivers of liens actually furnished. But if any subcontractor, labourer, materialman or other person refuses to furnish a waiver or release, or receipt in full, Contractor may furnish a bond satisfactory to Company to indemnify Company against any claim or lien or otherwise arising with respect to the claim of the person or persons refusing to furnish same.

SECTION 68.00: TITLE

68.01 The title to all work completed, all work in the course of construction, and all materials furnished by Company or by Contractor, irrespective of the location thereof, shall be in Company, but the ownership thereof by Company shall not absolve Contractor from liability for loss of or damage to same, nor from any other duty or responsibility for same as provided in the Contract Documents.

68.02 Contractor hereby waives, surrenders and relinquishes all lien or liens and all claims of lien which might arise with respect to the

Work under or by virtue of any mechanics' and/or materialmens' lien laws of the governing body wherein the Work is performed on any property of Company, real, personal or mixed, now owned or hereafter acquired, including, without limitation, the pipelines to be constructed hereunder and the rights-of-way under which the same are to be laid. The provisions of this Section shall be binding upon all subcontractors of the Contractor. Contractor shall hereafter and from time to time execute and deliver in valid and legal form such other and further instruments of release and surrender of such lien or liens as may be required of Contractor by Company in order to fully effectuate the intention of the Contractor to waive and surrender any such lien or claim. Contractor will require and insert provisions similar to this paragraph in any subcontract made in connection with the Work and will require any such subcontractor, in and by the terms of said subcontract, to waive all such liens or claims for lien.

SECTION 69.00: INDEMNITY AND COMPLIANCE WITH LAWS

69.01 Contractor shall observe and abide by all applicable laws, regulations, ordinances and other rules of the government, territory, or political subdivision thereof, or any other duly constituted public authority wherein the Work is done; and further agrees to indemnify and hold Company harmless from liability or penalty which may be imposed or asserted by reason of Contractor's failure or alleged failure to observe and abide thereby.

SECTION 70.00: NON-WAIVER OF DEFAULTS

70.01 Any failure or failures by Company at any time, or from time to time, to enforce or require the strict keeping and performance of any of the terms or conditions of this Contract shall not constitute a waiver or waivers of such terms or conditions and shall not affect or impair such terms or conditions in any way or the right of Company at any time to avail itself of such remedies as it may have for any breach or breaches of such terms or conditions, or any future breach or breaches of the terms or conditions of the Contract Documents.

SECTION 71.00: FORCE MAJEURE

71.01 It is agreed that in the event of either party being rendered unable wholly, or in part by force majeure, to carry out its obligations

under this Contract, then on such party's giving notice and full particulars of such force majeure in writing to the other party as soon as reasonably possible after the occurrence of the cause relied on, then the obligation of the party giving such notice, so far as it is affected by such force majeure, shall be suspended during the continuance of any inability so caused, but for no longer period; and such cause shall as far as possible be remedied with all reasonable dispatch. The provisions of this force majeure clause shall not apply, however, to obligations of Company to make payments to Contractor of money actually due under the Contract for work actually done and completed by Contractor under the terms hereof, or to obligations of Contractor to make payments of moneys or otherwise for liabilities and obligations actually incurred under the terms hereof.

71.02 The term "force majeure" as employed herein shall mean acts of God, strikes, lockouts, or other industrial disturbances, acts of the public enemies, wars, blockades, insurrections, riots, epidemics, landslides, lightning, earthquakes, fires, storms, floods, washouts, orders, restraints or prohibitions by the government in which the Work is located; or by any board, department, commission, or agency of the government having jurisdiction of the parties hereto, or jurisdiction over parties supplying labour, material, or any item or items necessary or desirable to the performance of this Contract, and without limitation any arrests and restraints of rulers and people, civil disturbances, explosions, and any other causes not within the control of the party claiming a suspension, which by the exercise of due diligence such party shall not have been able to avoid or overcome.

SECTION 72.00: TERMINATION FOR FAULT OF CONTRACTOR

72.01 Should Contractor at any time refuse or neglect to supply a sufficiency of properly skilled workmen or materials of the proper quality or quantity; fail in any respect to prosecute the Work or any portion thereof in an efficient, workmanlike, skillful and careful manner, or to the complete satisfaction of Company; fail to prosecute the Work with all speed consistent with the exercise of due diligence and skill, or shall fail to furnish and/or make the fullest utilization of the equipment agreed to be furnished by Contractor in the performance of this Contract; or, in the event the Contractual Agreement and/or the Contract Documents specify a definite time at which performance of the Work shall be completed, if the Contractor shall fail to comply with, or shall perform in bad faith, any of the terms of the Contractual Agreement, the Plans, the Specifications, these General Conditions, or any of the Contract Documents; then in any such event, each of which shall constitute an event of

default, Company, upon a certificate of the Engineer that sufficient cause exists to justify such action, may give written notice to Contractor stating the default, and if Contractor does not remedy such default within five (5) days after such notice is given, Company shall have the right, at its sole election, either to terminate the Contract as hereinafter provided in this Section 72.00, or to furnish any such labour or materials and/or equipment as may in Company's judgment be required to properly do the Work, and/or to complete same within the agreed time of completion, and to deduct the cost thereof from any money due or thereafter to come due to Contractor under the Contract. The furnishing of labour or material and/or equipment by Company shall not prevent Company from, or be deemed a waiver of its right to terminate the Contract as hereinafter provided in this Section 72.00. In the event of the happening of any such event of default and upon the giving of a certificate by the Engineer that sufficient cause exists to justify such action, or should Contractor become insolvent, should a petition in bankruptcy be filed by or against Contractor, or should Contractor take the benefit of any bankruptcy or insolvency law, or file any plan or arrangement thereunder, or if a receiver be appointed for Contractor, or any of its property, Company shall have the right to terminate the Contract and to terminate Contractor's right to proceed with the Work or any part thereof regardless of its state of completion. Without prejudice to any other right or remedy which Company may have against Contractor on account of such termination, Company may, if it so elects, take over the Work in its entirety and either complete the Work itself or award the Work to others to complete. In the event of such taking over of the Work by Company, or in the event Company awards the Work to others to complete, Company, for the purpose of completing the Work shall have the right to take possession of and use all or any part of Contractor's materials, plants, tools, equipment, (including appliances thereon), supplies and property of any and every kind provided by Contractor and may finish the Work by whatever methods it may deem expedient, including the hiring of any other contractor or contractors under such form of contract as Company may deem desirable. In any such case Contractor shall not be entitled to receive any further payment until the Work is finished. In the event Company takes over the Work or awards it to another contractor, as herein provided, and the cost of completing the Work provided for herein is more than the aggregate sum of money obtained by applying the unit prices specified in the Contractual Agreement to the Work so performed, then the Contractor shall pay to Company upon demand the amount of such excess. In the event Company performs all or any part of such remaining work, the cost thereof shall be deemed to include reasonable overhead of Company in supervising or carrying on the Work so performed and such other costs and damages as Company

may suffer by reason of the Contractor's default. For the purpose of this paragraph, the aggregate sum referred to shall be obtained by applying the unit prices specified in the Contractual Agreement to the part of the Work so taken over or constructed. The failure by Company to pursue any remedy afforded it in this Section 72.00 on the happening or continuance of any event or events of default shall not constitute a waiver of its right at any time to pursue the remedies herein afforded to it. No waiver by Company of its right to pursue such remedies on account of the happening of any event or events of default shall be or be considered to be a waiver of such rights of Company with respect to any subsequent event or events of default.

72.02 Notwithstanding anything herein contained to the contrary, it is understood and it is the intent of the parties hereto that the exercise of powers granted to Company in this Section 72.00 shall at all times be equitable and reasonable.

SECTION 73.00: TERMINATION FOR THE BEST INTERESTS OF COMPANY

73.01 In the event that Company shall determine, due to lack of right-of way, legal proceedings filed against it, international conditions, war, threat of war, economic conditions, shortages, embargoes, or otherwise, in the sole discretion of Company, that it is to the best interest of Company so to do, it shall have the right, upon the conditions hereinafter stated, to terminate this Contract.

73.02 In the event that Company shall so determine and elect, Company may so terminate this Contract by giving not less than five (5) days notice in writing to Contractor to that effect, and at the end of the notice period provided in such notice, this Contract shall terminate, and if Contractor has begun operations hereunder he shall forthwith cease such operations at the end of such notice period. Thereafter, neither party shall be liable one to the other with respect to this Contract, except that each party shall remain liable with respect to all obligations created or arising hereunder with respect to work done and matters arising prior to the effective date of such termination. Company shall also be obligated to pay to Contractor, promptly, the sums hereinafter agreed to be paid to Contractor for and on account of such termination for the best interests of Company.

73.03 In the event that Company shall elect and shall so terminate this Contract, prior to the time specified for commencement of the Work in the Contractual Agreement, and prior to the doing of any substantial work by Contractor, Company shall pay to Contractor, in full settlement and discharge of all of Company's liabilities to Contractor under this Contract, a sum to be computed as follows:

(a) If Contractor shall have moved machinery and equipment to the site of the Work preparatory to beginning construction, Company shall pay Contractor twice the amount of the actual field cost of moving his machinery and equipment in to the site of the Work, from the place at which said equipment was located at the time it was so moved in, such payment to be in full reimbursement for all costs of moving equipment in and out; provided, however, that in no event shall such cost exceed twice the amount of an amount equal to what would have been the actual field cost of moving said machinery and equipment from the place at which Contractor has its main office and principal place of business to the site of the Work; plus,

(b) A sum equal to two and one-half percent (2-1/2%) of the total cost of that part of the Work, specified by the Contract Documents, which is included in and described in the Contractual Agreement, as the unit cost of such part of the Work is prescribed in said Contractual Agreement; plus,

(c) All moneys actually earned by Contractor for work actually done by it under this Contract to the time of such termination.

73.04 In the event that Company shall elect, and shall so terminate this Contract after Contractor shall actually have done any substantial work, and after the time specified for commencement of the Work in the Contractual Agreement, Company shall pay to Contractor, in full settlement and discharge of all of Company's liabilities to Contractor under this Contract, and for all work done under this Contract, and for all work done under this Contract by Contractor, a sum to be determined and computed as follows:

(a) Contractor shall be promptly paid all moneys actually earned by Contractor for work actually done by him under this Contract to the time of such termination, and for which Contractor has not been paid, including the ten percent (10%) hold-back. With respect

to any work which then shall have been done and which shall not have reached a stage of completion entitling Contractor to a percentage payment thereon under the provisions of the Contractual Agreement, the Engineer shall estimate the percentage of completion as fairly and accurately as possible and based upon the percentages established in said agreement, determine the amount due to Contractor for such work; plus,

(b) An amount equal to five percent (5%) of the agreed price for doing that part of the Work which shall not have been commenced at the effective date of such termination, determined in accordance with the unit prices provided for in said agreement.

73.05 The payments provided to be made to Contractor in this Section 73.00 shall be in full discharge and satisfaction of all of Contractor's claims and demands of every kind and character arising under this Contract and arising in connection with all work and labour done and material furnished hereunder, including all costs of moving equipment in and out. Such payments shall also be deemed to be final payment to the Contractor, and shall only be paid to Contractor subject to and in accordance with all provisions of the Contract Document relating to "Final Acceptance", "Final Settlement", and "Final Payment".

73.06 Anything in this Section 73.00 to the contrary notwithstanding, it is understood and agreed that, in the event of termination of this Contract under the provisions of this Section, Company shall have the right to require the Contractor to complete any sections of the Work, at any place or places, and to any degree of completion, required by Company where to leave same incomplete would in Company's judgment operate to Company's detriment. Any work so required to be completed shall be paid for at the times and in the amounts for which same would have been paid for under this Contract if such termination had not occurred, and shall be made subject to all of the provisions of the Contract.

73.07 The right to terminate given to Company in this Section 73.00 is to be exercised solely at Company's election. Nothing contained herein shall in anywise abridge or alter any rights or privileges given to Company in any other portion of the Contract Documents, nor any of the rights particularly conferred, without limitation, by Sections 71.00 and 72.00 of these General Conditions relating respectively to Force Majeure and to Termination for Fault of Contractor.

SECTION 74.00: ASSIGNMENT

74.01 All covenants and agreements contained in the Contract Documents shall extend to and be binding upon the successors and assigns of Contractor and Company, except that Contractor shall not assign this Contract nor any moneys to become due hereunder without the prior written consent of Company, and any such assignment without such consent shall be null and void. Company shall have the right to assign this Contract and its right hereunder, but such assignment, except with consent of Contractor, shall not relieve Company of its obligations to pay for Work done hereunder by Contractor.

SECTION 75.00: NOTICES

75.01 Unless otherwise specifically provided in the Contract Documents with respect to notices or orders covering particular matters, any notice or order provided for in the Contract Documents shall be in writing and shall be conclusively deemed to have been given to Company, if (a) delivered personally to its designated representative at the site of the Work with authority to act for it, or (b) if mailed by registered mail, postage prepaid, addressed to Company at its principal office designated in the Contractual Agreement.

SECTION 76.00: CONFLICTS

76.01 Should any actual conflict or conflicts exist between or among the provisions of any of the Contract Documents, the order of priority in which the provisions of the various Contract Documents shall govern, one over the other, is as follows:

1. The Contractual Agreement
2. The Specifications
3. The Plans
4. The General Conditions

The fact that any one of the Contract Documents shall specify work or acts to be done in more particularity, or shall require more work or acts to be done in connection with any particular operation, than is required by another of the Contract Documents, or shall broaden the obligations of either

of the parties over the obligations expressed in other of the Contract Documents, is not and shall not be considered a conflict. It is the intention of the parties that the Contract Documents and their provisions shall be cumulative.

76.02 The Engineer shall decide as to the meaning and intent of any portion of the Specifications and Plans where the same may be thought to be obscure or in dispute and the Engineer shall have the right to correct any errors or omissions therein when corrections are necessary to the proper fulfillment of the intent of the Specifications and Plans. His decision thereon shall be final and conclusive, in the absence of fraud, capriciousness, unreasonableness or arbitrariness.

CONSTRUCTION SPECIFICATIONS

SECTION 100.00: SURVEY

100.01 The Engineer has made a preliminary aerial and ground reconnaissance of the main line right-of-way, and has marked on aerial maps a strip within which the proposed route should fall. If any changes or relocations are made, the Engineer shall provide the surveying equipment and personnel, and shall perform the necessary field survey work including the setting of markers and stakes for the final location of the line. These surveying personnel shall also chain the actual pipe as laid for the purposes of determining payments to the Contractor under the Contract.

100.02 A report of progress for each phase of the work as shown in the Contract which is performed per week by the Contractor shall be compiled by the Engineer, and such report shall be forwarded to Company's construction office weekly, with a copy delivered to the Contractor.

100.03 The Contractor shall cooperate to the fullest extent by informing the Engineer when pipe is to be lowered so that pipe measurements may be made before backfilling begins.

100.04 The Contractor shall familiarize himself with the terrain within the strip shown on the proposed route maps so that he will be cognizant of the entire route should a case of relocation within the strip arise.

SECTION 101.00: RIGHT-OF-WAY

101.01 The Company will provide a right-of-way within which the pipeline shall be constructed, and shall be approximately sixty (60) feet wide. Where it is not feasible for Company to secure a right-of-way of this width, the Contractor shall comply with the terms of the Right-of-Way Agreement and shall perform the work at such places so as to minimize the damage to the greatest degree possible, and, if necessary, trench by hand through such place at no additional expense to Company.

101.02 The Company will provide the pumping station sites in fee, with rights of ingress and egress thereto.

101.03 The Engineer will secure the necessary permits for railroad, highway, stream and river crossings, and shall stake the pipeline route at sufficient intervals to show the Contractor the location of the original right-of-way, the new right-of-way shall be staked by the Engineer for the Contractor.

101.04 Commencement of operations shall not be required in any tract where right-of-way easements are incomplete and for commencement of any operations, the Contractor shall first get a clearance from the Engineer.

SECTION 102.00: CLEARING

102.01 Rights-of-way shall be cleared prior to the stringing of pipe and the following requirements shall be complied with:

(a) The Contractor, before starting any clearing operations, shall familiarize himself with all special provisions included in the right-of way easements secured by the Engineer, and the Contractor's operations shall comply strictly with their provisions.

(b) The Contractor shall install gates in all fences, and these gates shall be kept closed at all times, except during the passage of equipment. He shall prevent livestock from entering or leaving the property and if so requested by Company, shall furnish a watchman or watchmen to enforce compliance with this requirement.

(c) The Contractor shall install temporary culverts in all drainage ditches, canals, creeks and other drainage structures which are dammed during operations, and where damage to property might occur because of drainage being blocked.

(d) The Contractor shall repair immediately any damage to bridges, private roads, fences, buildings or other property, which is of a nature that repairs cannot await the arrival of the clean-up crew.

(e) Where the right-of-way passes over or through farm yards, groves, orchards, gardens, lawns, valuable timber lands, subdivisions, or similar valuable properties, the Contractor shall comply with any special provisions in the rights-of-way agreements and shall limit his right-of-waying so as to minimize damages. Hand ditching if required at such places shall be at no additional cost to Company. The Contractor shall preserve all trees, shrubs, hedges, and lawns specified in the rights-of-way agreements as not to be disturbed, and shall pay for all damages resulting from failure to comply with these provisions.

(f) The Contractor shall limit his right-of-waying, clearing and grubbing as follows:

(1) The right-of-way shall be cleared to a minimum width of fifty (50) feet by the removal of all trees, brush, stumps, and other encumbrances, level with the surface of the ground, and the Contractor shall grub, or otherwise remove, stumps in the way of the ditch line. All debris shall be removed far enough from the ditch line so that the spoil bank from ditching operations will not fall on any foreign material that might become mixed with the excavated soil to be used as backfill and cause possible damage to the pipe.

(2) Clearing operations done with bulldozers shall be confined to the right-of-way; and trees, stumps, brush, etc., shall not be pushed off the right-of-way.

(3) Merchantable timber is to be cut into standard lengths and stacked along the right-of-way, or, it shall be cut and stacked in conformance with the right-of-way agreement between the owner and Company.

(4) All timber that is not merchantable, and all tree tops, brush, and stumps shall be burned or disposed of by the Contractor in a manner satisfactory to Company, and in accordance with any local regulations for disposal of such material.

(g) Irregularities in the right-of-way shall be graded preceding the trenching operation. The terrain shall be graded so as to allow passage of loaded trucks and equipment without undue wear and tear thereon, as well as to permit the ditch to be graded properly for the placement of field made pipe bends. The right-of-way shall be graded in a manner that will permit the laying of the pipeline at least in a normal ditch consistent with the maximum bending allowed in the pipe by these specifications.

(h) When telephone or utility lines interfere with the ingress and egress of the Contractor's tools and equipment and in the construction of the pipeline, the Contractor shall make the necessary arrangements to preserve the continuous use of the telephone or utility lines during the construction of the pipeline and shall pay the cost of maintaining their services.

(i) When working on or near roads, highways, railroads or other traffic ways the Contractor shall maintain the necessary day and night warning signs to protect all persons from injury, and to warn horse-drawn, automotive vehicles, etc., of the obstruction.

SECTION 103.00: UNLOADING, STORING, HAULING AND STRINGING

103.01 The Contractor shall obtain from the Provincial or State Highway Commission and other regulatory agencies, the necessary permits and certificates for the transportation requirements of the project, and the Contractor shall furnish Company with satisfactory evidence of compliance with all the rules and regulations of such agencies.

103.02 The Contractor shall make the necessary arrangements for receiving, unloading, and storing of all materials to be furnished by Company. Company in turn will deliver the material to the Contractor on board railroad cars, at the railroad stations, or sidings along the route of the pipeline, or at other central points as near to the route of the line as practicable. The Contractor shall unload and haul such materials to the points where needed, at no extra cost to Company. The Contractor shall be responsible for all delays resulting in demurrage, storage charges, or claims of any nature whatsoever occasioned by his failure to expedite the unloading of materials promptly on arrival at destination. If material schedules require intermediate stockpiling of pipe or other materials, Company will reimburse the Contractor for actual cost of such stockpiling, or make other arrangements to accomplish same without cost or charge to the Contractor.

103.03 No pipe shall be strung except on right-of-way which has been cleared in accordance with Section 102.00 of these Specifications. Unloading, hauling and/or stringing shall be done in such a manner as to prevent damage to the pipe and other material. The Contractor shall take all precautions to avoid damaging of pipe ends, or the denting, gouging, grooving or flattening of the pipe. In the event that the pipe is to be racked, it shall be done in such a manner as to prevent damage to the pipe and to the satisfaction of Company. Other material shall be stored in such a manner as to prevent damage thereto.

103.04 The Contractor shall string the pipe in such a manner so as to leave gaps across the right-of-way where requested by the landowner or tenants, to facilitate the movement of farm equipment or stock.

SECTION 104.00: TRENCHING

104.01 The Contractor shall excavate and maintain the trench in which the pipeline is to be laid. The trench shall be excavated on the staked line as established by Company and in accordance with the details shown in Exhibit A.

104.02 The bottom of the trench shall be uniformly graded and free from loose rock, large gravel, and other objects which might damage the pipe. Where additional depth of ditch is required at roads, railroads, ditches, streams, tile drains, underground pipeline or utility crossings, it shall be done at no additional expense to Company. At locations where the contour of the earth may require additional depth to eliminate unnecessary bending of the pipe, the Contractor shall provide such extra depth as directed, and at no additional expense to Company.

104.03 At underground pipeline or utility crossings falling within the limits of the trench, the trench shall be dug to such a depth as is required to install the new pipeline above or below the existing line with a minimum clearance of twelve (12) inches between the two lines while still maintaining the minimum cover.

104.04 Where underground drain tile is encountered, the trench shall be dug so that the pipeline may be installed either above or below the tile as may be required by Company. Where any drain tile is cut or removed, the Contractor shall make immediately such temporary repairs as are required to make the drain line function properly at Contractor's expense.

104.05 When the trench is excavated through land where livestock is confined, or through cultivated fields where it is desirable for the landowner or tenant to have a passageway across the trench, the Contractor shall provide safe, temporary bridges for crossing the trench.

104.06 Rock Trench is defined as trench which can be excavated to the contract requirements only by drilling and blasting. When such is encountered, the trench shall be of such a depth as to provide twenty (20) inches of cover over the completed pipeline, and an additional depth of four (4) inches below the bottom of the pipeline. The trench so excavated shall then be padded with earth free from rock to a minimum thickness of four (4) inches, so that the protective coating on the pipe will be protected from any hard points of rock projecting above the bottom of the trench. In addition, where rock has been excavated from the trench, and it is intended to refill the trench in whole or in part with such excavated rock, the

pipe shall be covered with earth, free from rock, on the sides and top of the pipe to a reasonable depth to prevent injury to the pipe from rock or rock fragments which may be replaced in the trench. "Extra heavy" rock shields may be used in lieu of padding the trench with dirt if the Contractor elects to use and pay for same; however, in any case all possible precautions shall be taken in order to prevent damage to the protective coating on the pipe. The trench shall not be refilled with excavated rock or boulders without approval from Company.

104.07 When blasting is necessary, extreme care shall be exercised so as not to scatter loose rock over the right-of way and cultivated fields, or cause damage to property, whether it be off the right-of-way or on the right-of-way. If loose rock is scattered over cultivated fields, the Contractor shall pick up such rock and dispose of same to the satisfaction of the Company.

104.08 The Contractor shall secure all necessary permits and conform with all legal requirements in connection with the use of explosives if they are used anywhere on the work. The Contractor shall take every precaution to protect the public and his workmen from any injury or harm which might arise because of the use of explosives, and shall use only experienced workmen to supervise, handle, haul, load, and shoot the explosives. Proper disposition must be made of any and all refuse from dynamite containers and cartridges, and in no case shall they be disposed of in the backfill of the trench.

104.09 The Contractor's attention is also called to marshy and high water table conditions which may require the use of pumps, well points, or other means of dewatering. No additional compensation shall be due to the Contractor for increased costs due to this condition.

104.10 It will be required that the pipe be buried across swamps and marshes. In this case the trench may be cut by blasting, or any other practicable means to assure the required cover of thirty-six (36) inches over the pipe. Weights or heavy coating required for these crossings shall be calculated in the field by the Engineer and weight shall be added to the pipe in accordance with his instructions. The cost of placing the necessary weights or coating shall be in accordance with the unit price in the Contract.

SECTION 105.00: INTERNAL CLEANLINESS OF PIPE

105.01 Contractor shall use all reasonable precautions to keep the new pipe free from dirt and debris as is possible, and each joint of pipe

shall be swabbed prior to alignment and welding. Prior to stopping each day's work, all pipe ends on the pipeline shall be nightcapped with a suitable cover so as to prevent the entrance of dirt, small animals, water and foreign matter into the pipeline. These nightcaps shall remain in place where the line is interrupted at crossings, under railroads, rivers, etc.

SECTION 106.00: BENDING

106.01 The Contractor shall lay all pipe so that it conforms reasonably with the contour of the trench. All bends that are to be used as overbends shall be made in such a manner that the middle of the bend shall clear the high point of the bottom of the ditch. All sags shall fit snug to the bottom of the ditch.

106.02 All bends shall be made by the use of an approved bending machine of proper size. No undue stretching or thinning of the pipe wall shall be permitted. All bending shall be made to as long a radius as possible and no bend shall be made within six (6) feet of any circumferential joint. If, however, the pipe is double jointed, bends shall not be closer to the weld than one (1) pipe diameter. Any pipe that is buckled by the bending operation shall be cut out and replaced at the expense of the Contractor. The minimum radius bend shall be forty (40) feet.

106.03 It is the intent of this specification to produce bends which shall minimize the distortion of the pipe and which in no way will impair its strength.

SECTION 107.00: WELDING

107.01 All welding machines, line-up clamps, beveling machines and other welding equipment shall be of an approved type and shall be maintained by the Contractor in good working order. Types of welding rod approved by the Engineer for various grades of API line pipe shall be furnished by the Contractor, and the size of the rod and number of beads required per weld shall also be subject to the approval of the Engineer.

107.02 The API Standard Specifications 1104 for Field Welding of Pipelines and revisions thereto will govern the welding process to be used in the construction of the pipeline except as specified in this Section. A copy of the aforementioned API Specifications immediately follows and is made a part of this Section.

API Std. 1104
4th Edition
May, 1956

STANDARD FOR FIELD WELDING OF PIPE LINES

ISSUED BY

AMERICAN PETROLEUM INSTITUTE
DIVISION OF TRANSPORTATION
1625 K STREET, N.W.
WASHINGTON 6, D. C.

FOR SALE BY

AMERICAN PETROLEUM INSTITUTE
50 WEST 50TH STREET
NEW YORK 20, NEW YORK

Price 50 Cents

FOREWORD

This specification was prepared by a formulating committee on which were representatives of the American Petroleum Institute, the American Gas Association, the Pipe Line Contractors Association, the American Welding Society, the Society for Non-destructive Testing, and representatives of the pipe manufacturers and individuals associated with related industries.

It is the purpose of this specification to produce the highest quality welds obtainable on a commercial basis by skilled welders, using approved welding procedures, materials, and equipment. It is also the purpose of this specification to produce the highest quality radiographs obtainable by skilled operators, using approved technique and equipment, to ensure the proper analysis of welding quality and defects.

This specification is intended to apply to cross-country pipe lines for the transmission of crude petroleum, petroleum products, and natural gas.

The committee has had the cooperation of many engineers interested in design, construction, and operation of oil and gas pipe lines, and desires to express appreciation for their wholehearted and valuable assistance.

It is realized that revisions will be necessary from time to time to keep abreast of developments, and constructive suggestions will be welcome.

Publication of the specification presented herein has been authorized by the American Petroleum Institute and the American Gas Association.

API-AGA JOINT COMMITTEE ON OIL AND GAS PIPE LINE FIELD WELDING PRACTICES

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A. G. BARKOW, *Secretary* *

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F. W. ZILM

Pipe Line Contractors Association

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H. C. PRICE
RAY L. SMITH

Society for Non-destructive Testing

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J. W. DUTLI
ROY O. SHIEBEL, JR.
JOHN SMACK

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D. R. LOPER
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P. A. MILLS

American Gas Association

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J. L. FOSTER
C. T. SCHWEITZER

Pipe Manufacturers

G. E. FRATCHER
G. R. LOCKE
J. C. SIEGLE
A. B. WILDER

American Welding Society

S. A. GREENBERG
A. N. KUGLER
V. T. MALCOLM
C. B. VOLDRICH

Radiographic Subcommittee

A. G. BARKOW
A. F. COTA
R. F. HOLSTE †
D. R. LOPER
H. C. PRICE

* 20 North Wacker Drive, Chicago 6, Illinois.
(After October 1, 1956 the address will be 122 South Michigan Avenue, Chicago 3, Illinois)
† NEMA Representative.

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PART I—WELDING SPECIFICATION

1.0 WELDING PROCESSES

Welds shall be made by the manual shielded metal-arc process. All requirements affecting the quality of the completed welds shall apply equally to roll welding and position welding.

Note: Until this specification is expanded to include automatic welding processes applicable to the multiple jointing of pipe, the quality of such automatic welds shall be at least equal to the minimum standards of acceptability herein specified.

1.1 DEFINITIONS OF TERMS

1.11 DEFINITIONS

Unless otherwise stated, definitions pertaining to welding as used in this specification conform to the standard definitions established by the American Welding Society and contained in the American Welding Society publication *Standard Welding Terms and Their Definitions,* latest edition.

1.12 GENERAL TERMS

1.121 COMPANY

The term "company" as used in this specification shall mean the owner company or the engineering agency in charge of construction. The company may act through an inspector or other authorized representative.

1.122 CONTRACTOR

The term "contractor" as used in this specification shall include the prime contractor and any subcontractors engaged in work covered by this specification.

1.123 WELD

The term "weld" as used in this specification shall mean the completed circumferential weld joining two sections of pipe.

1.124 WELDER

The term "welder" as used in this specification shall refer to the person making the manual weld.

1.125 ROOT BEAD

The term "root bead" as used in this specification shall mean the first or stringer bead which initially ties two lengths of pipe together.

1.126 POSITION WELDING

The term "position welding" applies to a position of welding in which the weld is deposited around the circumference of the pipe without rolling the pipe.

1.127 ROLL WELDING

The term "roll welding" applies to the position of welding in which the axis of the pipe is approximately horizontal. The pipe is rotated so that the welding is done at or near top center at all times.

1.128 SHALL AND SHOULD

For the purpose of this specification the word "shall" indicates mandatory requirements; the word "should" indicates recommended practices.

1.2 EQUIPMENT

Welding machines and appurtenances thereto shall be of size and type suitable for the work, and shall be maintained in such condition as to insure acceptable welds, continuity of operation, and safety of personnel. Welding machines shall be operated within the amperage and voltage ranges recommended for each size and type of electrode. Any equipment which does not meet these requirements shall be repaired or replaced upon request of the company representative.

1.3 MATERIALS

1.31 PIPE

This specification shall apply to field welding of pipe conforming to API Std. 5L Line Pipe Specifications and 5LX High Test Line Pipe Specifications and applicable American Society for Testing Material Standards and shall also apply to field welding of pipe not manufactured in conformance to

those specifications, provided the physical and chemical properties comply with such specifications.

1.32 ELECTRODES

1.321 TYPE AND SIZE

All electrodes shall conform to the requirements of the *AWS-ASTM Specifications for Mild Steel Arc-Welding Electrodes* or *AWS-ASTM Specifications for High Tensile and Low Alloy Steel Arc-Welding Electrodes*, latest edition.

1.322 STORAGE AND HANDLING

Electrodes shall be stored in unopened original containers. Electrodes shall be adequately stored to prevent moisture loss or moisture absorption, and shall be handled in such a manner as to avoid damage to the coating. Electrodes in opened containers shall be protected from excessive moisture changes. Electrodes which show signs of deterioration or damage shall not be used.

1.4 WELDING PROCEDURE

1.41 WELDING REQUIREMENTS

Prior to starting of production welding under this specification, a pipe joint welding procedure shall be established and qualified (Par. 1.412) to demonstrate that welds having suitable mechanical properties and soundness can be made by this procedure.

1.411 RECORDS

All qualified pipe joint welding procedures shall be recorded in detail and shall be adhered to during subsequent construction, except where a change is specifically authorized by the company as provided for in Par. 1.4122. (Exhibits A and B.)

1.412 PROCEDURE QUALIFICATION

1.4121 *Procedure Specification*

The Procedure Specification shall include the following:

a. Process
(Manual metal arc-welding, submerged automatic arc-welding).

b. Pipe
(API Std. 5L, 5LX, ASTM or other specification designations, or give chemical analysis and physical properties).

c. Diameter and Wall Thickness
(Range of diameters and pipe wall thicknesses).

Note: Pipe size groups for qualification may be as follows:

Outside Diameter, inches:
- 4½ and smaller
- 6⅝ to 12¾ inclusive
- 14 to 20 inclusive
- Over 20

Wall thickness, inches:
- ½ inch and less
- Over ½ inch

d. Joint Design
(Angle of bevel and size of root face; root opening or spacing between abutting pipe ends).

e. Filler Metal
(Classification number).

f. Size of Electrodes and Number of Beads
(Size electrode used for each bead; sequence of beads).

g. Electrical Characteristics
(Current and polarity, voltage and amperage for each size electrode).

h. Position
(Roll or position welding).

i. Direction of Welding
(Vertical up or down).

j. Number of Welders
(Minimum number of root bead welders, minimum number of second bead welders).

k. Time Lapse between Passes
(Maximum time between root bead and second bead, maximum time between second bead and finish bead).

l. Type of Line-Up Clamp
(Internal or external).

m. Removal of Line-Up Clamp
(After root bead welding is 50% completed; after root bead is 100% completed).

n. Cleaning
(Power tools, hand tools).

o. Preheat, Peening, Stress Relief
(Methods, temperature, temperature

control methods, ambient temperature range in accordance with Par. 1.426).

p. Sketches and Tabulations
(Sketches on separate sheets showing the joint design and weld bead sequence, together with tabulations of the data required under sub par. c, d, f, and g).

1.4122 *Essential Variables*

Welding procedure must be re-established as a new procedure specification and must be completely requalified when any of the changes listed below are made in the procedure. Changes other than those given below may be made in the procedure without the necessity for requalification, provided the specification is revised to show these changes.

a. Change in Pipe Metal
(From ASTM or API Std. 5L and 5LX Grade X42 groups to API Std. 5LX groups in excess of Grade X42 and vice versa).

b. Change in Joint Design
(From V-groove to U-groove, etc. Change in dimensions of the welding groove, however, are not essential variables of the procedure specification).

c. Change in Pipe Size and Wall Thickness
(From one group or combination to another).

d. Changes in Filler Metal
(From one classification number to another).

e. Change in Electrode Size.

f. Decrease in Number of Root Bead Welders.

g. Change in Time Lapse Between Root and Second Bead.

h. Change in Direction
(Vertical-down to Vertical-up or vice versa).

1.4123 *Preparation and Welding of Test Joint*

a. The pipe material, filler metal, and welding shall comply with the procedure specification.

b. The pipe material shall consist of pipe nipples of the same diameter group, wall thickness group (1.4121 c), and specification as the pipe used in the line, or as specified by the company.

c. The weld shall be made using the same welding technique and with approximately the same arc-welding speed to be used in actual line work.

1.4124 *Type and Number of Test Specimens*

The type and number of test specimens shall be as specified in Table 1.

1.4125 *Removal of Test Specimens*

Test specimens shall be removed as shown in Fig. 1, shall be spaced approximately equidistant around the pipe, and shall be prepared for tests as shown in Fig. 2, 3, and 4, and as prescribed in Par. 1.5241, 1.5251, and 1.5261.

1.4126 *Test Results*

1.41261 Tensile Test

Tensile test specimens shall be ruptured under tensile load. The tensile strength shall be computed by dividing the maximum load at failure by the least cross-

TABLE 1

Type and Number of Test Specimens for Welding Procedure Test

Pipe Size: Outside Diameter (Inches)	Total Number of Specimens	Number of Specimens			
		Tensile	Nick Break	Bends	
				Root	Face
4½ and smaller	4	2	2	..	..
6⅝ to 12¾ inclusive	8	2	2	2	2
14 and larger	16	4	4	4	4

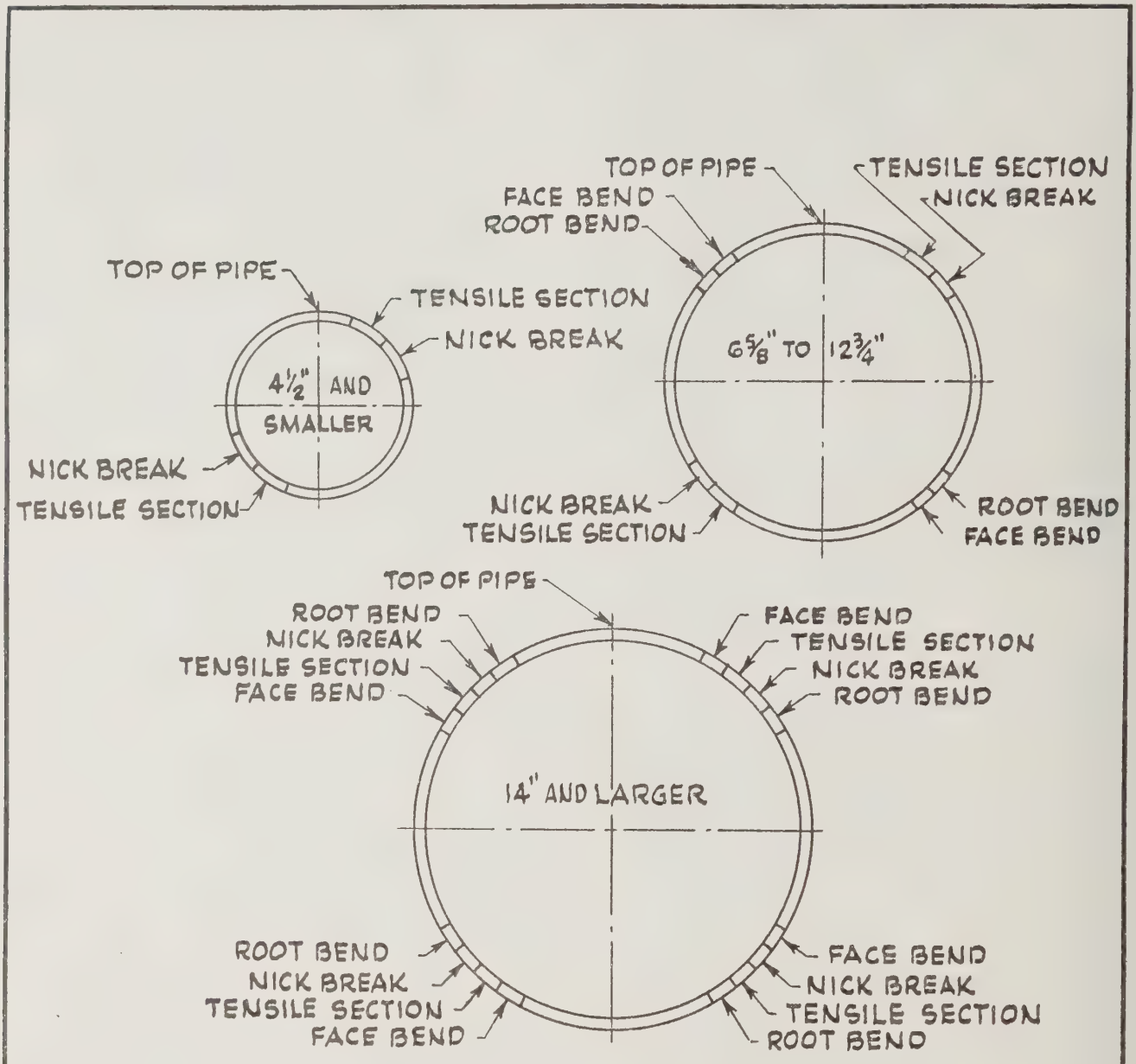


FIG. 1

LOCATION OF TEST SPECIMENS
PROCEDURE QUALIFICATION TEST WELD

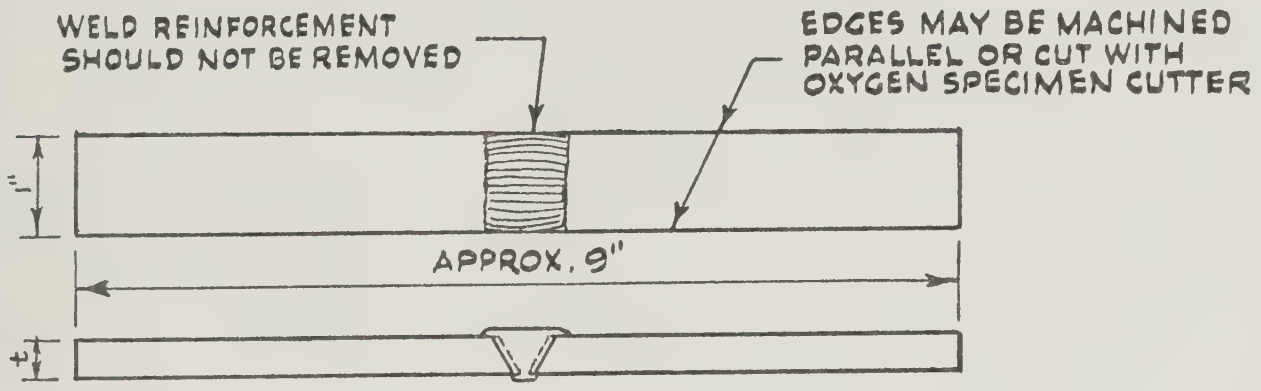


FIG. 2. TENSILE TEST SPECIMEN

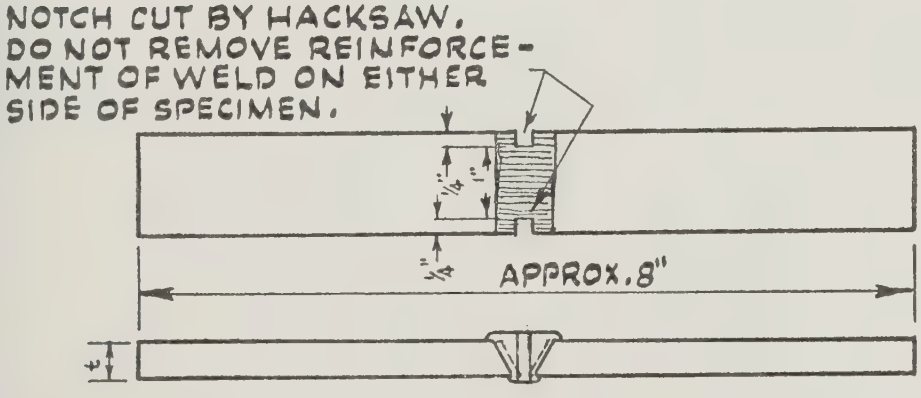
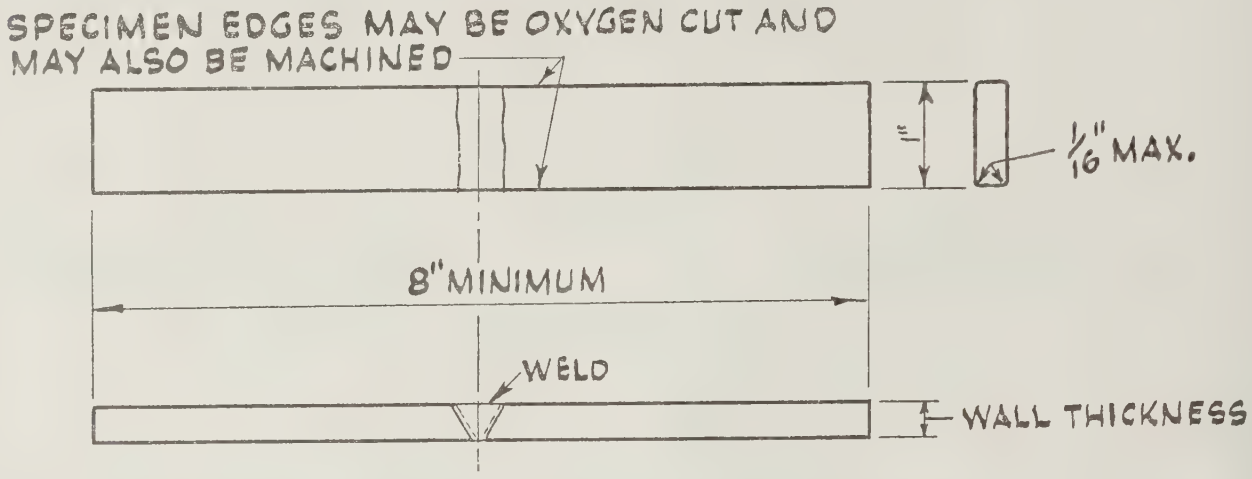


FIG. 3. NICK-BREAK TEST SPECIMEN



GUIDED-BEND TEST SPECIMEN
FIG. 4

sectional area of the specimen as measured before load is applied. The tensile strength of each such specimen shall be equal to or greater than the minimum specified tensile strength of the pipe material. If the specimen breaks in the pipe metal outside of the weld or fusion line, the test shall be accepted as meeting the requirements provided the strength is not more than 5 per cent below the specified minimum tensile strength of the pipe metal. Each specimen subjected to tensile load shall meet the above requirements.

1.41262 Bend Test

Face-bend and root-bend specimens shall be bent in a testjig having dimensions shown in Fig. 5. The specimen shall be placed on the die of the testjig with the weld at mid-span. The face-bend specimen shall be placed with the face of the weld directed toward the gap and the root-bend specimen shall be placed with the root of the weld directed toward the gap. The plunger of the jig shall be forced into the gap until the curvature of the specimen is approximately U-shaped. The bend test shall be considered acceptable if no crack or other defect exceeding ⅛ in. in any direction is present in the weld metal or between the weld and the pipe material after bending. Each specimen subjected to the bend test shall meet the above requirements.

(Cracks which originate along the edges of the specimen during testing and which are less than ¼ in. measured in any direction shall not be considered.)

1.41263 Nick-Break Test

Nick-break specimens shall be hacksaw-notched from both edges of the specimen and at the center of the weld. They shall be broken by pulling or hammer blows at the center or one end of the specimen (Par. 1.5251).

The exposed surface of the specimen shall show no more than 6 gas pockets per square inch, with the greatest dimension not to exceed $\frac{1}{16}$ in. Slag inclusions shall not be greater than $\frac{1}{32}$ in. in depth or $\frac{1}{8}$ in. in width, and shall be separated by at least $\frac{1}{2}$ in. of sound weld metal. Each specimen subjected to the nick-break test shall meet the above requirements.

1.42 DESIGN AND PREPARATION OF THE JOINT

1.421 DETAILS

The details of the pipe joint design and preparation shall be in accordance with the following requirements and as prescribed in the qualified welding procedure (Par. 1.4121 d.).

1.422 BEVEL

1.4221 *Mill Bevel*

Pipe ends shall be provided with mill bevels conforming to the joint design used in the welding procedure specification, Par. 1.4121 d.

1.4222 *Field Bevel*

Pipe ends shall preferably be field beveled by machine tool or machine oxygen cutting. Manual oxygen cutting may also be used if so authorized by the company. The beveled ends shall be reasonably smooth and uniform, and dimensions shall be in accordance with the qualified welding procedure (Par. 1.4121 d.).

1.423 ROOT OPENING

The root opening (space between abutting pipe ends) shall be as given in the qualified welding procedure (Par. 1.4121 d.). The root opening should be approximately $\frac{1}{16}$ in.

1.424 ALIGNMENT

1.4241 *Offset*

The alignment of the abutting pipe ends shall be such as to minimize the offset between pipe surfaces. For pipe of the same nominal wall thickness, the offset shall not exceed $\frac{1}{16}$ in. Any greater offset caused by dimensional variations shall be equally distributed around the circumference of the pipe. Hammering of pipe to obtain proper line up should be held to a minimum.

1.4242 *Internal Line-Up Clamp*

An internal line-up clamp shall be used, whenever practical, for all sizes of pipe 16 in. and larger, and may be used for pipe of smaller diameters. Internal line-up clamps may be removed after the root bead is 50 per cent completed, provided the completed part of the root bead is in segments of approximately equal lengths, and the segments are equally spaced about the circumference of the pipe. However, if conditions make it difficult to prevent movement of the pipe, or if the weld will be unduly stressed, the root bead shall be completed before releasing clamp tension.

1.4243 *External Line-Up Clamp*

An external line-up clamp shall be used where it is impractical to use an internal line-up clamp. Root bead segments used in connection with external clamps shall be uniformly spaced around the circumference of the pipe and shall have an accumulative length of not less than 50 per cent of the pipe circumference before the clamp may be removed.

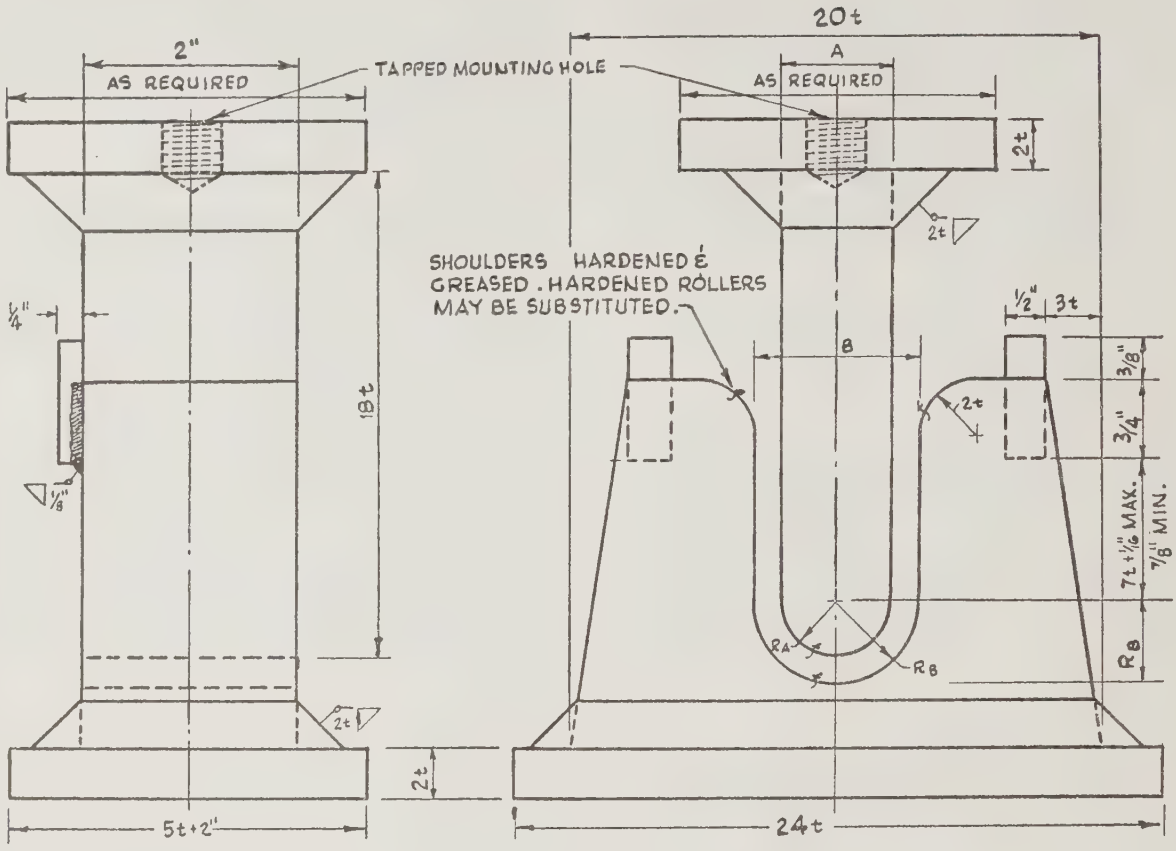
1.425 BEVEL SURFACE CONDITION

Surfaces to be welded shall be free from loose scale, slag, rust, grease, paint, and other foreign materials. The surfaces shall also be smooth, uniform, and free of fins, tears, and other defects which adversly affect proper welding.

1.426 WEATHER CONDITIONS

Welding shall not be done when the quality of the completed weld would be impaired by the prevailing weather conditions, including but not limited to air-borne moisture, blowing sands, or high winds. Wind shields may be used when practical. The company representative shall decide if weather conditions are suitable for welding.

The qualified welding procedure shall spec-



GUIDED-BEND TEST JIG DIMENSIONS

	PIPE GRADE		
	X42*	X46	X52
RADIUS OF PLUNGER ..... R_A	3t	3½t	4t
RADIUS OF DIE ..... R_B	4t	4½t	5t
WIDTH OF PLUNGER ..... A	6t + 1/16"	7t + 1/16"	8t + 1/16"
WIDTH OF GROOVE IN DIE ..... B ...	8t + 1/8"	9t + 1/8"	10t + 1/8"

t = TABULATED WALL THICKNESS OF PIPE

FOR INTERMEDIATE GRADES OF PIPE, THE ABOVE DIMENSIONS OF THE BENDING JIG SHALL CONFORM TO THOSE SHOWN FOR THE NEXT LOWER GRADE OR SHALL BE PROPORTIONAL THERETO.

*NOTE: ALSO APPLIES TO ALL GRADES API 5L AND ASTM

FIG. 5

JIG FOR GUIDED-BEND TEST

ify what pre-heating and temperature control practices shall be used when weather conditions affect the weldability of the steel.

1.427 CLEARANCE

When the pipe is welded above ground, the working clearance around the pipe at the weld should not be less than 16 inches. When the pipe is welded in the trench, the bell hole shall be of sufficient size to provide the welder or welders ready access to the joint.

1.428 ROOT BEAD

The entire root bead, for either roll welding or position welding, shall be made with the pipe in a stationary position. It is mandatory that at least two welders be used, operating simultaneously and in opposite quarters, when welding root beads for all sizes of pipe 16 in. and larger. Movement of the pipe during welding of the root bead shall be avoided.

1.429 CLEANING BETWEEN BEADS

Scale and slag shall be removed from each bead and groove. Cleaning may be done with either hand or power tools.

1.43 POSITION WELDING (STOVE-PIPE METHOD)

1.431 WELDING PROCEDURE

All position welds shall be made with the pipe resting on skids at the specified height over or at the side of the ditch (Par. 1.427).

1.432 FILLER AND FINISH BEADS

The number of filler beads should be such that the completed weld will have a reinforcement of not less than $\frac{1}{32}$ in. and not more than $\frac{1}{16}$ in. After the root bead has been completed, for pipe 16 in. and larger, it is recommended and may be made mandatory by the company to add the second bead immediately, after which the specified number of beads may be made by finish welders.

Two beads shall not be started at the same location. The face of the completed weld should be approximately $\frac{1}{8}$ in. greater than the width of the original groove. The completed weld shall be thoroughly brushed and cleaned.

1.44 ROLL WELDING

1.441 MAINTAINING ALIGNMENT

At the option of the company, roll welding will be permitted, provided alignment is maintained by use of skids or structural framework to accommodate two or more full lengths of pipe and having an adequate number of roller dollies to prevent sag in the supported lengths of pipe (Par. 1.428).

1.442 FILLER AND FINISH BEADS

The number of filler and finish beads shall be such that the completed weld should have a reinforcement of not less than $\frac{1}{32}$ in. and not more than $\frac{1}{16}$ in. In any case at least two beads (in addition to the root bead) shall be used.

Each filler bead should be approximately $\frac{1}{8}$ in. in thickness.

The face of the completed weld should be approximately $\frac{1}{8}$ in. wider than the width of the original groove. As the welding progresses, the pipe shall be rolled to maintain welding at or near the top of the pipe. The completed weld shall be thoroughly brushed and cleaned.

1.5 QUALIFICATION OF WELDERS

1.51 REQUIREMENTS

Welders shall have been qualified in accordance with a procedure specified by Par. 1.412. If so required by the company, qualification of welders shall be conducted in the presence of a company representative. The number and type of tests to be made shall be optional with the company, but not less than 2 of the 3 tests (Par. 1.524, 1.525, and 1.526) shall be made, and no more than 12 specimens shall be taken from any one weld, depending upon the size of the pipe.

Alternatively, the welder may be qualified by radiographic inspection in accordance with Par. 1.55.

1.511 PROCEDURE FOR MULTIPLE QUALIFICATION

a. A welder who has qualified with a high-strength material such as the API Std. 5LX group in excess of Grade X42 may be considered qualified to weld pipe in the lower strength qualifications such as the ASTM or API Std. 5L groups.
b. A welder who has qualified in one group of diameters 12¾ in. OD or less may be considered qualified for any size pipe 12¾ in. OD or less.
c. A welder qualified in any group greater than 12¾ in. OD may be considered qualified in all sizes greater than 12¾ in.
d. A welder qualified to weld material greater than ½ in. may be considered qualified to weld material of any thickness less than the qualifying thickness.
e. A welder making an original Procedure Qualification Test is automatically qualified for that classification.

1.52 TEST WELDS

1.521 WELDING OF TEST WELDS

Welders to be qualified shall be required to make a position weld, using pipe nipples, or sections thereof in each quadrant of the same diameter group, wall thickness group (Par. 1.4121 c.) and specification as the pipe used in the line, or as specified by the company, and using electrodes of the specified type and size. Before starting the test weld, the welder being tested shall be allowed a reasonable time to adjust the welding machine. The welder making the qualification test weld shall use the same welding technique and proceed with the welding at the same arc speed and use the same welding current he will use if and when he passes the test and is permitted to work on the line.

1.522 SAMPLING OF TEST WELDS

From the completed test weld, the number of specimens cut will depend upon the size of the pipe and requirements of the company. It is recommended that specimens be cut from the completed weld in accordance with Table 2.

Specimens shall be removed as shown in Fig. 6, and shall be spaced approximately equidistant around the pipe.

Specimens shall be air-cooled to ambient temperature before testing.

1.523 VISUAL EXAMINATION

The weld must be free of cracks, inadequate penetration, burn-through, and other obvious defects, and it must present a neat workman-like appearance. Undercutting adjacent to the final bead on the outside of the pipe shall not exceed 1/32 in. in depth.

1.524 TENSILE TESTS

1.5241 *Preparation*

Tensile-test specimens (Fig. 2) shall be approximately 1 in. wide; the weld reinforcements, both at the face and at the root of the weld shall not be removed. Specimens may be oxygen-cut and no additional machining or preparation will be necessary, provided the sides are parallel and free from notches or unevenness which may adversely affect the test results.

1.5242 *Results*

If two or more of the specimens tested break in the weld or at the junction of the weld and the parent metal, and also fail to develop the minimum specified tensile strength of the pipe metal, the welder shall be disqualified.

1.525 NICK-BREAK TESTS

1.5251 *Preparation*

Nick-break test specimens (Fig. 3) may be oxygen-cut, and no other preparation will be necessary. The specimens shall be hacksaw-notched on both edges of the specimen at the center of the weld to cause failure in the weld metal, and shall be broken: (a) by pulling in a suitable testing machine; (b) by supporting the ends and striking the center of the specimen with a heavy hammer; or (c) by supporting one end of the specimen in a vise and striking the other end with sharp hammer blows. The exposed area of the fracture shall have a minimum width of 1 in.

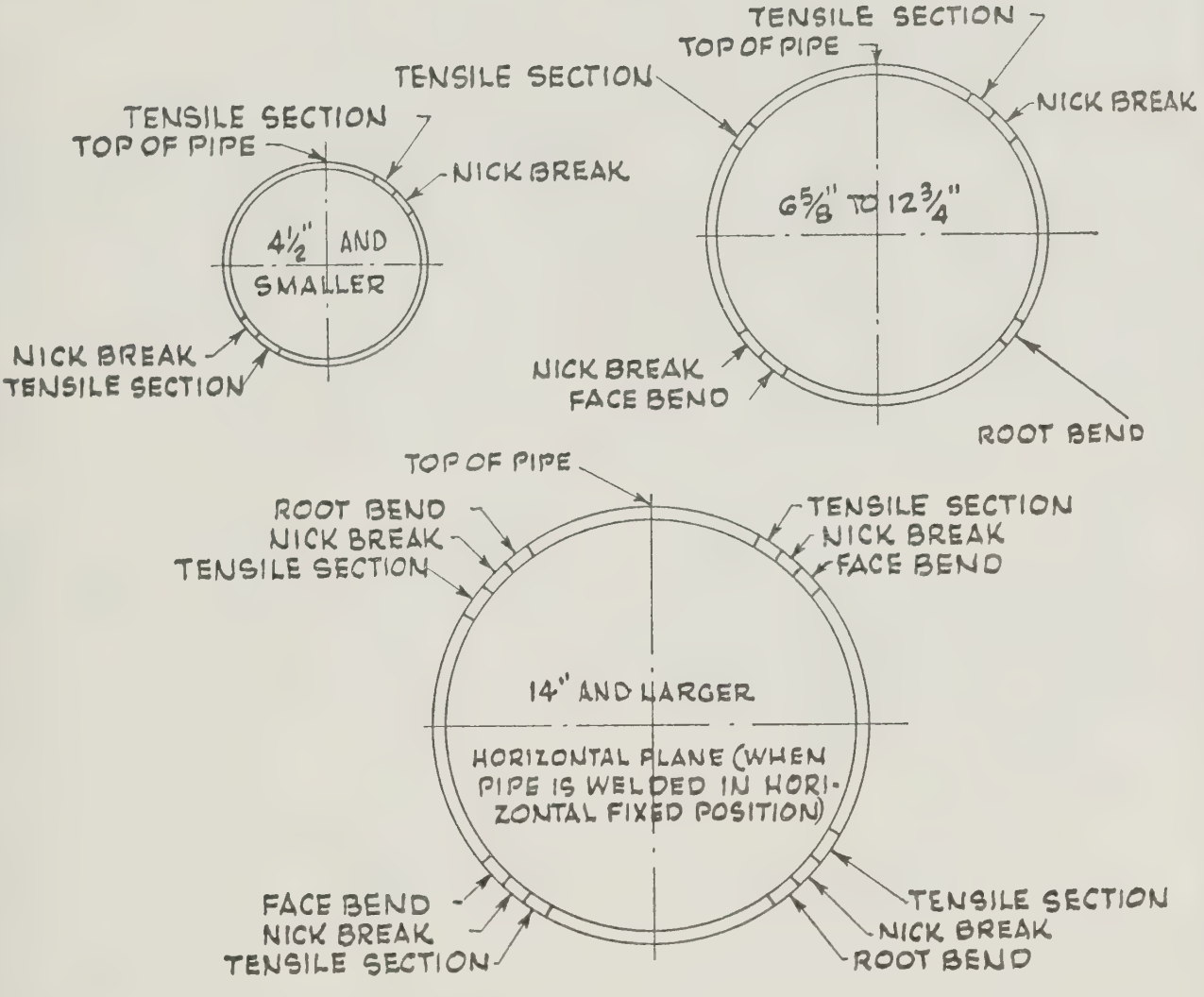


FIG. 6

LOCATION OF TEST SPECIMENS
WELDERS QUALIFICATION TEST WELD

TABLE 2

Type and Number of Test Specimens for Welder Qualification Test

Pipe Size: Outside Diameter (Inches)	Recommended Number of Specimens	Number of Specimens			
		Tensile	Nick Break	Bends	
				Root	Face
4½ and smaller	4	2	2	..	..
6⅝ to 12¾, inclusive	6	2	2	1	1
14 and larger	12	4	4	2	2

1.5252 *Results*

The nick-break test shall show complete penetration and fusion throughout the entire thickness of the weld specimen. If, in the opinion of the company representative, inadequate penetration occurring in one of the test specimens is not representative of the weld, the specimen may be replaced by another specimen cut adjacent to the specimen that was rejected. The exposed surface shall show no more than 6 gas pockets per square inch with the greatest dimension not to exceed $\frac{1}{16}$ in. Slag inclusions shall be not greater than $\frac{1}{32}$ in. in depth or $\frac{1}{8}$ in. in width, and shall be separated by at least $\frac{1}{2}$ in. of sound weld metal. The welder shall be disqualified if any one specimen shows defects exceeding these limitations.

1.526 BEND TESTS

1.5261 *Preparation*

Bend-test specimens (Fig. 4) shall be approximately 1 in. wide and may be oxygen cut. Both the cover and root bead reinforcement shall be removed flush with the pipe wall. Final removal of excess metal shall leave the surface free of deep scratches, and any remaining scratches shall be transverse to the weld.

Sharp edges shall be reduced to a smooth radius. One-half the number of specimens shall be subjected to face-bend tests, and the other half of the number of specimens shall be subjected to root-bend tests.

1.5262 *Method*

All bend-test specimens shall be tested in a guided-bend testjig, similar to that shown in Fig. 5. Each specimen shall be placed on the die with the weld at mid-span. Face-bend specimens shall be placed with the face of the weld directed toward the gap; root-bend specimens shall be placed with the root of the weld directed toward the gap. The plunger shall be forced into the gap until the curvature of the specimen is approximately U-shaped.

1.5263 *Results*

The bend test shall be considered acceptable if:

1. No crack or other defect exceeding $\frac{1}{8}$ in. in any direction is present in the weld metal or between the weld and the pipe material after bending. (Cracks which originate along the edges of the specimen during testing and that are less than $\frac{1}{4}$ in. measured in any direction shall not be considered.)

Note: Welds in high-test pipe, API Std. 5LX, which may not bend the full U-shape shall be qualified under Clause 2.

2. The specimen cracks or fractures during bending and the exposed surface shows: (a) complete penetration and fusion throughout the entire thickness of the weld specimen; (b) no more than 6 gas pockets per square inch with the greatest dimension not to exceed $\frac{1}{16}$ in.; and (c) no slag inclusions greater than $\frac{1}{32}$ in. in depth or $\frac{1}{8}$ in. in width and separated by at least $\frac{1}{2}$ in. of sound metal. (If necessary, the specimen shall be broken apart to permit examination of the fracture.)

Should one of the welder's bend test specimens fail to meet these requirements, and, in the opinion of the company representative, lack of penetration occurring is not repre-

sentative of the weld, the test specimen may be replaced by an alternative specimen cut adjacent to the one that failed. The welder shall be disqualified if the alternative specimen also shows defects exceeding the specified limits.

1.53 QUALIFICATION

The welder may be recognized as qualified only if the test weld presents a neat appearance (Par. 1.523) and the specimens are acceptable as to tensile strength (Par. 1.524) and soundness (Par. 1.525, 1.526).

1.54 RETEST

If, in the mutual opinion of the company and contractor representatives, failure of a welder to pass the test was because of unavoidable conditions or conditions beyond his control, such a welder may be given a second opportunity to qualify. No further retests shall be given until the welder has submitted proof of subsequent welder training acceptable to the company.

1.55 WELDER QUALIFICATION BY RADIOGRAPHY

At the option of the company, the qualification weld may be examined by radiographic inspection in lieu of the tests specified in Par. 1.52. The welder shall be disqualified if the test weld fails to meet requirements of radiographic inspection as prescribed in Par. 1.7.

Radiographic inspection shall not be used for the purpose of locating sound areas or areas containing discontinuities and thereafter making destructive tests of such areas to qualify or disqualify a welder.

1.56 IDENTIFICATION OF WELDS

Each welder shall identify his work in the manner prescribed by the company. Steel-die stamping shall not be used except as permitted by the company.

1.57 RECORDS

The company shall maintain a record of the welders employed, until the line is placed in operation, showing the date and results of qualification tests and the identification mark assigned to each. (Exhibit B.)

1.6 INSPECTION AND TESTING OF PRODUCTION WELDS

1.61 RIGHTS OF INSPECTION

The company shall have the right of inspection of all welds by the methods set forth in this specification. The inspection may be made both during the welding operation and after the weld has been completed. The frequency of radiographic inspection shall be as specified by the company. The company shall have the right to accept or reject any weld not meeting the requirements of this specification.

1.62 METHODS OF INSPECTION

Welds may be inspected by non-destructive means or by removing for physical tests one or more completed welds as selected and designated by the company. Non-destructive testing may consist of radiographic examination or other methods acceptable to the company. Trepanning methods of testing shall not be used.

1.63 DESTRUCTIVE TEST

The company shall have the privilege of making any tests to check the quality of the welds made by each welder, and the right to cut from the line any weld that, in the opinion of the company, appears to be defective.

Welds for routine sampling shall, whenever possible, be selected at a time and location which will least interfere with efficient and orderly construction operations.

Any weld so removed and tested shall have specimens cut therefrom and tested in the manner prescribed in Par. 1.523, 1.524, 1.525, and 1.526. The welder or welders may be disqualified from further work on the line if the weld fails to comply with the specified requirements.

PART II—STANDARDS OF ACCEPTABILITY

1.7 STANDARDS OF ACCEPTABILITY

1.71 LIMITATION OF DISCONTINUITIES

1.711 Introduction

The standards of acceptability are applicable primarily to determination of size and type of defects located by radiography or other nondestructive test methods.

These standards may also be applied to determination of size and type of defects located by visual inspection. These standards are not to be confused with the allowable defects as described and limited in the examination of physical test specimens.

1.712 Pipe Defects

Laminations, split ends, or other defects in the pipe shall be cropped, repaired, or removed from the line as directed by the company representative.

1.72 Measurement of Defects

For the purpose of this specification, all measurement shall be taken clockwise, from the top center of the pipe, facing in the direction of construction. The term "in 12-in. lengths" means in succeeding 12-in. lengths measured from the top center of the pipe. The length of a defect is measured along the circumferential weld.

1.721 Inadequate Penetration and Incomplete Fusion

Inadequate penetration is defined as the incomplete filling of the bottom of the weld groove with weld metal. Incomplete fusion is defined as the lack of bond between beads or between the weld metal and the pipe metal.

Any individual defect due to inadequate penetration or incomplete fusion shall not exceed 1 in. in length. The total length of such defects in any 12-in. length of weld shall not exceed 1 in. The total length of such defects in any two succeeding 12-in. lengths shall not exceed 2 in. and individual defects shall be separated by at least 6 in. of sound weld metal.

1.722 Burn-Through Areas

A burn-through area is that portion in the root bead where excessive penetration has caused the weld puddle to be blown into the pipe.

Any individual burn-through area shall not exceed ½ in. in length. The total length of burn-through area in any 12-in. length of weld shall not exceed 1 in. The total length of burn-through area in any two succeeding 12-in. lengths shall not exceed 2 in., and individual defects shall be separated by at least 6 in. of sound weld metal.

1.723 Slag Inclusions

A slag inclusion is a non-metallic solid entrapped in the weld metal, or between the weld metal and the pipe metal. Elongated slag inclusions are usually found at the fusion zone. Isolated slag inclusions are irregularly shaped inclusions and may be located anywhere in the weld.

1.7231 *Elongated Slag Inclusions (Wagon Tracks)*

Any elongated slag inclusions shall not exceed 2 in. in length or $\frac{1}{16}$ in. in width. The total length of elongated slag inclusions in any 12-in. length of weld shall not exceed 2 in. and the total length of elongated slag inclusions in any two succeeding 12-in. lengths shall not exceed 4 in. Adjacent elongated slag inclusions shall be separated by at least 6 in. of sound weld metal. Parallel slag lines shall be considered as individual defects if their individual width is greater than $\frac{1}{32}$ in.

1.7232 *Isolated Slag Inclusions*

The maximum width of any isolated slag inclusion shall not exceed ⅛ in. The total length of isolated slag inclusions in any 12-in. length of the weld shall not exceed ½ in., nor shall there be more than four isolated slag inclusions of the maximum width

of ⅛ in. in this length. The total length of isolated slag inclusions in any 24-in. length of weld shall not exceed 1 in. Adjacent isolated slag inclusions shall be separated by 2 in. of sound weld metal.

1.724 POROSITY OR GAS POCKETS

Porosity or gas pockets are voids occurring in the weld metal, and are usually spherically shaped.

The maximum dimension of any individual gas pocket shall not exceed 1/16 in. Maximum distribution of gas pockets shall not exceed that shown in Fig. 7 and 8 of this specification.

1.725 CRACKS

No weld containing cracks, regardless of size or location, shall be acceptable except as provided for in Par. 1.73.

1.726 ACCUMULATION OF DISCONTINUITIES

Any accumulation of discontinuities having a total length of more than 2 in. in a weld length of 12 in. is unacceptable. Any accumulation of discontinuities which total more than 10 per cent of the weld length of a joint is unacceptable.

1.727 UNDERCUTTING

Undercutting is the burning away of the side walls of the welding groove at the edge of a layer of weld metal, or the reduction in the thickness of the pipe wall adjacent to the weld and where it is fused to the surface of the pipe.

Undercutting adjacent to the cover bead on the outside of the pipe shall not exceed 1/32 in. in depth and 2 in. in length. Undercutting adjacent to the root bead on the inside of the pipe shall not exceed 2 in. in length.

1.73 REPAIR OR REMOVAL OF DEFECTS

1.731 COMPANY AUTHORIZATION OF REPAIRS

The company may authorize repairs of defects in the root and filler beads, but any weld that shows evidence of repair work having been done without authorization by the company may be rejected.

Minor cracks in the surface and filler beads may be repaired when so authorized by the company, but any crack penetrating the root bead or the second bead shall be cause for complete rejection of the weld. The entire weld shall then be cut from the line and replaced. Minor cracks shall be defined as cracks visible in the surface bead and not more than 2 in. in length.

Repairs may be made to pin holes and undercuts in the final bead without authorization, but must meet with the approval of the company.

1.732 REMOVAL AND REPAIR OF DEFECTS

Before repairs are made, injurious defects shall be entirely removed by chipping, grinding, or oxygen gouging to clean metal. All slag and scale shall be removed by wire brushing. Preheating of such an area may be required by the company.

Such repaired areas should be re-radiographed, or inspected by the same means previously used. No further repairs shall be allowed in repaired areas.

1.74 RETESTS

The company shall have the right to retest repaired welds in accordance with Par. 1.6.

PART III—RADIOGRAPHIC PROCEDURE

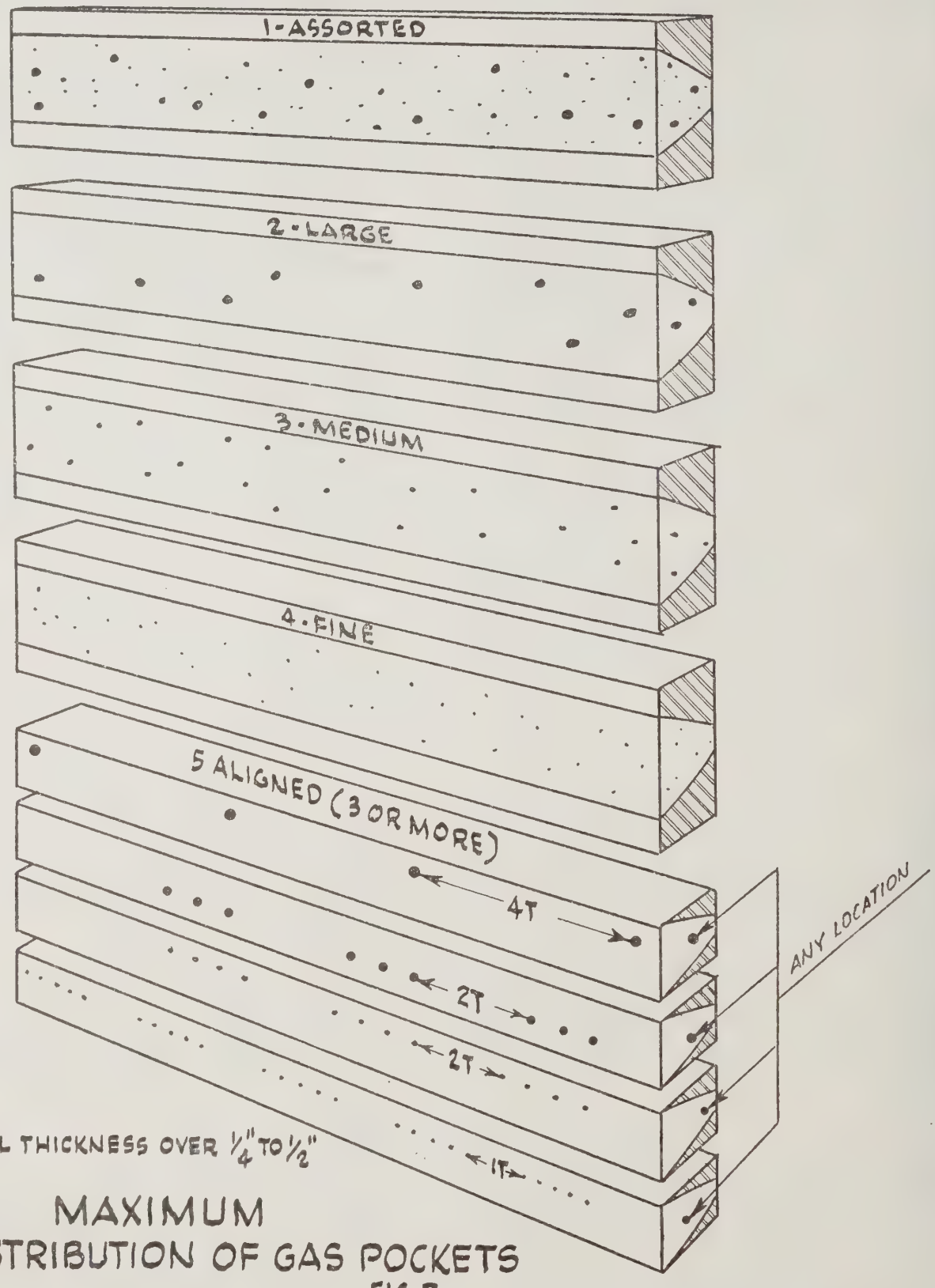
1.8 RADIOGRAPHIC INSPECTION

1.81 PRODUCTION OF RADIOGRAPHS

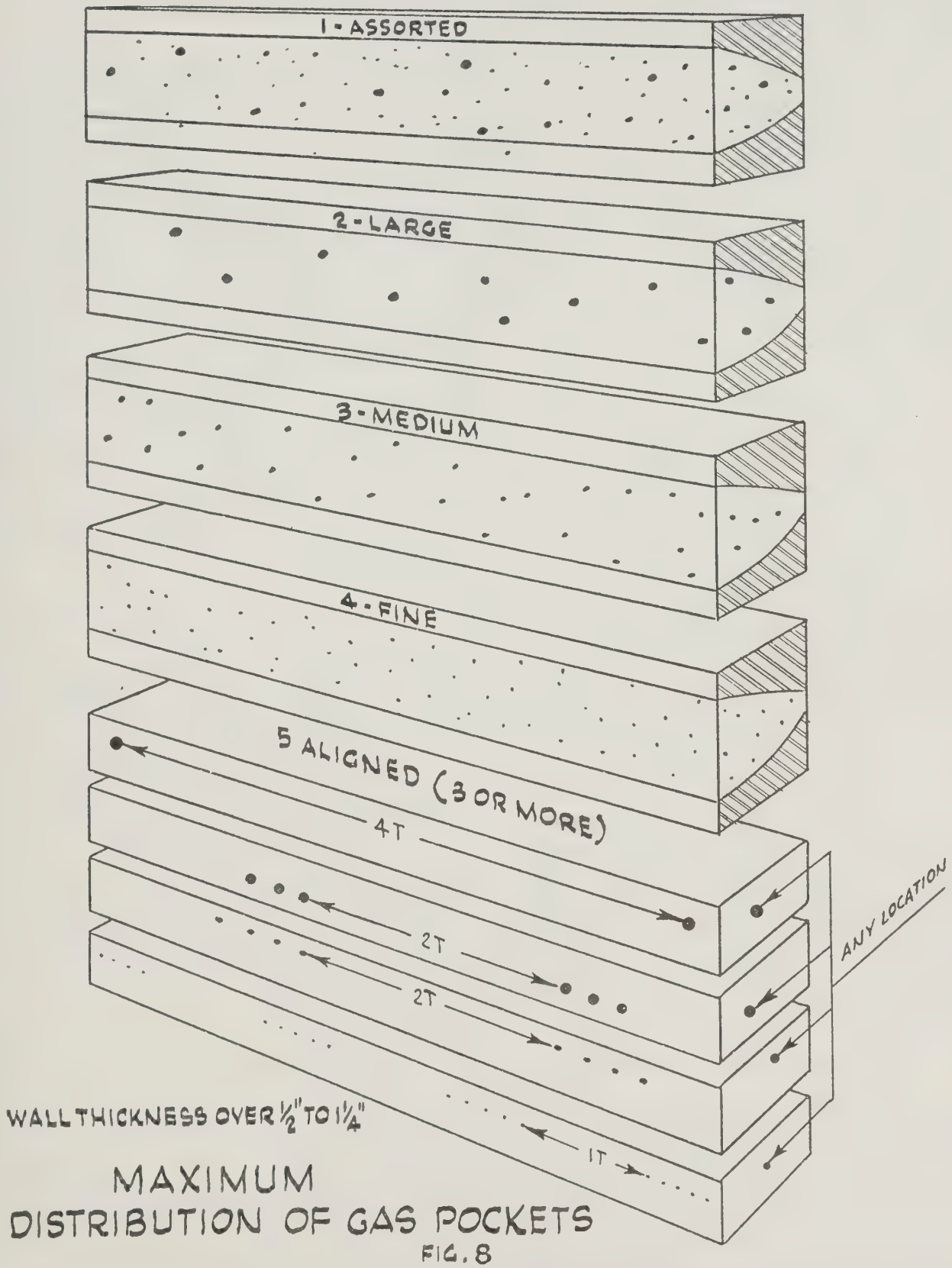
1.811 INTRODUCTION

This standard covers radiography of pipe welds using X-rays or gamma-rays as sources of radiation. It is the purpose of this standard to insure radiographic quality adequate for the inspection of pipe line welding within the practical limits of the equipment, procedures, and the materials available.

All requirements referring to the quality



MAXIMUM
DISTRIBUTION OF GAS POCKETS
FIG. 7



MAXIMUM
DISTRIBUTION OF GAS POCKETS

FIG. 8

of the resulting radiographs shall apply equally to X-rays and gamma-rays.

The use of radiographic inspection and the frequency of its use shall be at the option of the company.

1.812 Radiographic Sources

X-ray machines and radioactive materials may be used as sources of radiation. The source of radiation may be located either inside or outside of the pipe. When located on the outside of the pipe, the image of either one or both walls may be acceptable for interpretation provided the radiographic geometry and resolution complies with the requirements of Par. 1.821, 1.822, and 1.823.

1.813 Equipment and Materials

1.8131 *X-Ray Machines* (*X-ray*)

X-ray machines capable of producing radiation within the limits indicated in Par. 1.821 should be employed. The radiation generated, the effective source size and position, size of field, and the filterscreen combinations governing the use of these machines shall be as specified in Par. 1.822, and 1.823, and should be as specified in Par. 1.821 and 1.824, respectively.

1.8132 *Radioactive Sources* (*Gamma-ray*)

The equivalent effective voltage of radio-isotopes should determine the selection of the radioactive material. The effective source size and position, size of field, and filterscreen combination governing the use of radioactive sources shall be as specified in Par. 1.822 and 1.823 and should be as specified in Par. 1.824.

1.814 ASME Penetrameters

ASME type penetrameters (Fig. 9) should be used on each radiographic area. The thickness of the penetrameters shall be 2 per cent of the parent metal thickness, unless the company specifies that the penetrameter shall be 4 per cent of the parent metal thickness. The penetrameter shall be used on the source side of the plate within 1 in. of the acceptable limits of the film coverage as specified in Par. 1.823 and Table 3. The image of the smallest hole shall be clearly defined.

1.815 Standard Test Radiograph

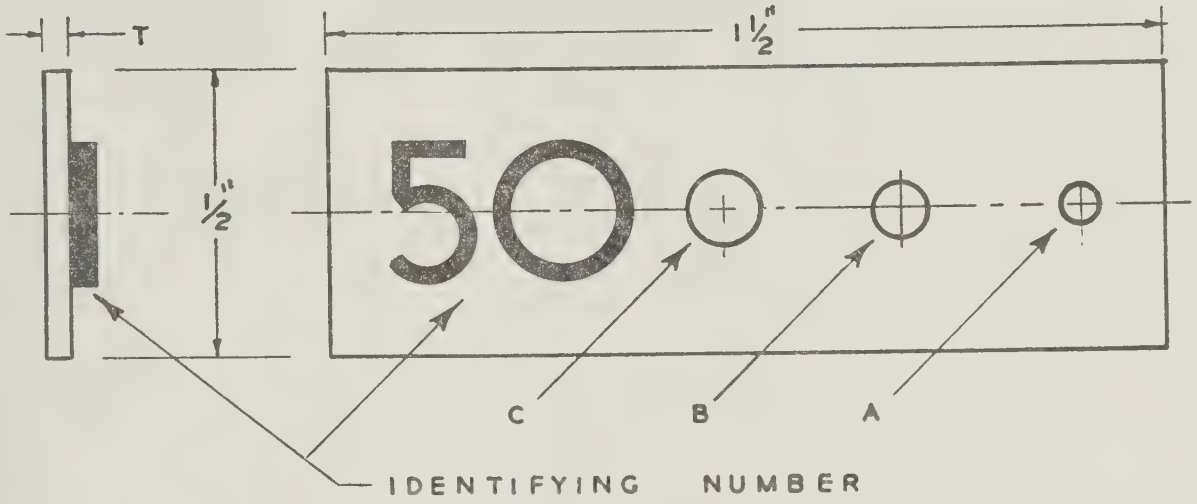
Whenever it is impractical to place the penetrameter on every film or on the source side, the radiographer shall demonstrate that the production technique of exposure, film processing, and film handling will produce the specified sensitivity on a simulated specimen, using the same exposure, geometric relation, film, and processing technique that will be used in production radiographs. The resultant radiograph shall be considered the Standard Test Radiograph. This test shall be repeated at the option of the company representative whenever any apparent deliberate change has been made in the operating technique, or whenever production films vary appreciably in detail, contrast, or density from the Standard Test Radiograph.

1.816 Film Identification Markers

All films shall be clearly identified by lead numbers, letters, and/or markers so that location of the weld and any discontinuity in the weld can be quickly and accurately located. The company may specify the identification procedure desired. Whenever more than one film is used to inspect a complete circumferential weld, the identification markers shall appear on each film, and each weld section reference marker location shall be common to two successive films so as to establish that the entire weld has been examined.

1.817 Film-Viewing Illuminators

Viewing illuminators shall be used which will produce sufficient light intensity so that all portions of the radiograph of the weld and base metal will transmit sufficient light for comfortable viewing by the company representative. Viewing illuminators should provide sufficient light intensity to penetrate 2.5 density.



T = SPECIFIED PERCENT OF PIPE WALL THICKNESS

A DIAMETER = (2)(T)

B DIAMETER = (3)(T)

C DIAMETER = (4)(T)

THIS RELATIONSHIP TO PENETRAMETER THICKNESS IS CONSTANT FOR EITHER 2 PERCENT OR 4 PERCENT PENETRAMETERS. THE DIAMETER NEED NOT BE LESS THAN 1/16 INCH.

HOLES SHALL BE ROUND AND DRILLED PERPENDICULAR TO THE SURFACE.

HOLES SHALL BE FREE OF BURRS BUT EDGES SHALL NOT BE CHAMFERED.

EACH PENETRAMETER SHALL CARRY A LEAD IDENTIFICATION NUMBER REPRESENTING, TO 2 SIGNIFICANT FIGURES, THE MINIMUM THICKNESS OF THE PLATE FOR WHICH IT MAY BE USED.

STANDARD PENETRAMETER

FIG. 9

1.82 RADIOGRAPHIC TECHNIQUE

1.821 X-RAY VOLTAGE

X-ray voltage for total parent metal thicknesses should not exceed the following values:

Total Parent Metal Thickness, (Inches)	Maximum X-Ray Voltage (Kilovolts)
¼ and under	110
9/32 to ⅜ inclusive	130
13/32 to ½ inclusive	160
21/32 to ⅝ inclusive	200
29/32 to 1½ inclusive	300

1.822 RADIATION SOURCE SIZE, POSITION AND MINIMUM SOURCE FILM DISTANCE

X-ray or gamma-ray source shall not have an effective size greater than specified in the following tabulation for the indicated source to film distance:

Source-Film Distance (Inches)	Effective Source Size (Millimeters)
6	2.5
10	3.5
18 and over	6.0

The distance between the source of radiation and the film shall not be less than 7 times the distance between the weld surface farthest removed from the film and the film surface. When practical this distance should be 10 times or greater.

The source of radiation shall not be offset more than 5 deg from the plane of the girth weld seam except where necessary for elliptical projection. In this case the angle may be increased the minimum amount required to separate the images so that there is no superimposition within the limits of Par. 1.823.

1.823 SIZE OF RADIATION FIELD

When pipe weld inspection is made with source and film both outside the pipe and located diametrically opposite each other, the maximum permissible total film length acceptable for interpretation per exposure shall not exceed that indicated in Table 3. This table covers pipe with nominal wall thicknesses to 1½ in.

1.824 LEAD SCREEN APPLICATIONS

Lead screens should be used for equivalent voltages more than 150 kv, according to type of source. Lead screens should be employed in thicknesses approximately as follows:

	Equivalent Voltage	Thickness of lead (Inches)
X-ray	(150 kv and over)	.005
Iridium^{192}	(200 kv to 600 kv)	.005
Cobalt^{60}	(1200 kv)	.020
Radium^{226}	(800 kv to 2300 kv)	.005 to .020
Cesium^{137}	(600 kv)	.010

In all exposures, the film holder should be backed by a sheet of 1/16 in. lead when using radiation generated at 110 kv or less, and by ⅛ in. lead when using gamma- or X-radiation generated at voltages over 110 kv.

1.83 RADIOGRAPHIC FILM

1.831 TYPE OF FILM

Radiographic films of high contrast and relatively fine grain shall be used. Films shall not have a base density of more than 0.30.

1.832 FILM STORAGE

All films shall be stored in a clean, dry place where they will not be subjected to: (a) chemical vapors; (b) industrial illuminating gas; (c) X-ray or gamma-radiation; (d) excessive heat; and (e) undue pressure. If there is any question regarding the condition of the unexposed film, sheets from the front and back of each package and/or a length of film equal to the circumference of each original roll, without exposure to light or radiation, shall be processed in the normal manner. If this processed film shows fog, the entire box or roll from which the test film was removed shall be discarded, unless additional test films prove that the remaining film of the box or roll is free from pre-exposure fog exceeding 0.30.

1.833 FILM DENSITY

Film shall be exposed so that the average density shall not be less than 1.5 and so that the density through the thickest portion of the weld metal shall be not less than 1.0.

TABLE 3

Acceptable Limits of Diagnostic Film Length
Par. 1.823

SOURCE-FILM DISTANCE, IN.	PIPE DIAMETER (Inches)												
	6⅝	8⅝	10¾	12¾	14	16	18	20	22	24	26	28	30
7	7.0												
9	5.8	9.6											
11	4.8	8.0	11.0										
13	4.4	6.7	9.5	13.2									
14	4.2	6.2	8.5	11.6	15.4								
16	4.0	5.8	7.9	10.5	13.6	17.3							
18	3.9	5.6	7.5	9.8	12.5	15.6	19.0						
20	3.8	5.4	7.2	9.3	11.7	14.5	17.6	22.2					
22	3.8	5.2	6.9	8.9	11.1	13.6	16.5	20.0	24.4				
24	3.7	5.1	6.7	8.6	10.8	12.9	15.5	18.5	22.2	26.5			
26	3.7	5.0	6.6	8.3	10.3	12.3	14.8	17.4	20.7	24.2	28.8		
28	3.6	5.0	6.4	8.1	10.0	11.9	14.2	16.7	19.6	22.5	26.2	30.6	
30	3.6	4.9	6.3	7.9	9.7	11.5	13.7	16.0	18.6	21.3	24.5	28.3	32.6
32	3.5	4.8	6.2	7.8	9.5	11.2	13.3	15.4	17.9	20.3	23.2	26.7	30.2
34	3.5	4.8	6.2	7.7	9.3	11.0	13.0	15.0	17.3	19.6	22.3	25.5	28.7
36	3.4	4.7	6.1	7.6	9.1	10.8	12.7	14.6	16.8	19.0	21.5	24.4	27.4
40								14.1	16.0	18.1	20.3	22.8	25.4
46								13.4	15.2	17.0	19.0	21.3	23.4
54								12.8	14.1	15.8	17.8	19.8	21.7

1.834 Processing Defects

Radiographs shall be free from all artifacts caused by bending, dirt, faulty screens, static marks, light leakage, and handling. At the option of the company, any films containing artifacts interfering with the interpretation of the radiograph shall be discarded and the welds shall again be radiographed.

1.84 PROCESSING CHEMICALS

1.841 Developers

Commercial powders, concentrated liquids, or dry chemicals shall be mixed, maintained at proper strength and temperature, used, and discarded in accordance with manufacturer's recommendations.

1.842 Stop Bath

An acid stop bath should be used between the developer and fixer.

1.843 Fixer

When the clearing time of the fixer exceeds 5 min., i.e., the total fixing time exceeds 10 min., the solution shall be discarded.

1.844 Washing

Radiographs shall be processed to allow storage of films without discoloration for at least three years.

All films should be washed in clean running water equivalent to three complete changes of fresh water. The temperature of the wash water should not exceed 90 degrees fahrenheit.

Alternate A—All film should be washed in a series of no less than three 5-gallon tanks. The films should be advanced from one tank to the next in five minute steps with occasional agitation in each tank and each film drained thoroughly before transfer. Wash water should be discarded after washing 6,000 sq. in. of film. When four 5-gallon tanks are used in series, 30,000 sq. in. of film can be washed before discarding and replacing water.

Alternate B—Commercial fixer-neutralizer solution may be used to remove residual chemicals. After fixing for a period of not more than twice the clearing time, radiographs should be drained thoroughly and transferred to the fixer-neutralizer solution.

After soaking in the fixer-neutralizer solution for five minutes, the radiographs should be drained and transferred to a tank of clean water and left in this tank for a minimum of one hour or washed in clean running water for five minutes. Every five gallons of fixer-neutralizer solution should be discarded and replaced after processing 48,000 sq. in. of film area. Every five gallons of clean water should be discarded and replaced after processing 5,000 sq. in. of film area, or two 5-gallon tanks in a series of clean water will process 25,000 sq. in. of film area.

1.845 DARK ROOM

The film processing room and all accessories shall be kept clean and dust free at all times.

1.85 RADIATION PROTECTION

The radiographer shall be responsible for the protection and personnel monitoring of every man working with or near X- or gamma-radiation. This protection and monitoring shall comply with the regulations of *U. S. Bureau of Standards Handbooks HB-42, HB-54,* and *HB-60.* The total tolerance or dosage shall not exceed 0.3 roentgen per week or 6¼ milliroentgens per hour.

Personnel monitoring shall be accomplished by film badges and/or pocket ionization chambers. All records of radiation received by all personnel in the vicinity of the X-ray or gamma-ray inspection apparatus shall be retained.

Where radioactive materials are used, the area affected by radiation shall be surveyed and the limits of hazard posted.

1.86 RADIOGRAPHERS

The company shall have the option of examining the qualifications of all radiographers to insure that all radiographs shall be taken, processed, and interpreted only by experienced technicians. All interpretations shall be made in accordance with Par. 1.7.

TO USERS OF API STD. 1104

The introduction of a Procedure Qualification and Record requirement into this specification is in conformity with numerous requests and brings this specification in line with American Welding Society and similar specifications. A form for both the Procedure Record and Qualification Test has been appended as Exhibit "A" and Exhibit "B," respectively. While these forms are not mandatory, they may be adopted if found convenient or may be changed to suit the individual user.

The Committee is at all times anxious to improve this specification for the production of better quality welds and will give full consideration to all comments received.

The Committee is also desirous of receiving Procedure Specification Records from the users of API Std. 1104 so as to further assist in the development work of the Standard.

All information and comments which the user might wish to voluntarily contribute to the Committee should be addressed to:

Mr. R. G. STRONG, *Chairman*
Joint Subcommittee on Field Welding
c/o Natural Gas Pipeline Company of America
* 20 North Wacker Drive
Chicago 6, Illinois

* (After October 1, 1956, the address will be 122 South Michigan Avenue, Chicago 3, Illinois)

EXHIBIT A

(Sample Form)

Ref. Par. 1.412

STANDARD PROCEDURE SPECIFICATION NO.

For Metal Arc Welding of Steel Line Pipe, Fittings and Flanges

A. Process: .....

B. Pipe Metals: .....

C. Diameter and Wall Thickness: .....

D. Joint Design: .....

E. Filler Metal: .....

F. Size of Electrodes and Number of Beads: .....

G. Electrical Characteristics: .....

H. Position: .....

I. Direction of Welding: .....

J. Number of Welders: .....

K. Time Lapse between Passes: .....

L. Type of Line-up Clamp: .....

M. Removal of Line-up Clamp: .....

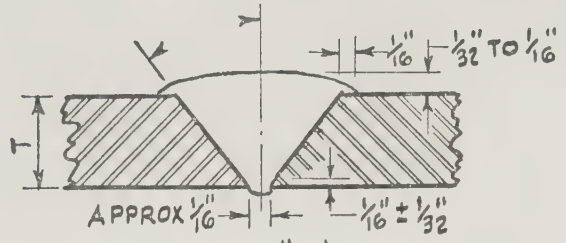
N. Cleaning: .....

O. Preheat, Peening, Stress Relief: .....

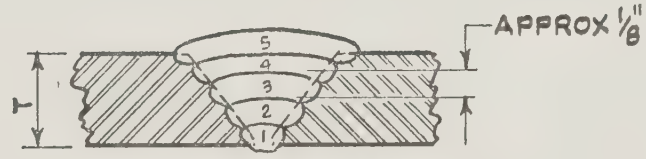
Tested: .....Welder: .....
Approved: .....Welding Supt: .....
Adopted: .....Chief Engineer: .....

(Sample Form)

PREPARATION OF BASE MATERIAL



STANDARD "V" BEVEL
BUTT JOINT



SEQUENCE OF BEADS

TABLE I. ROD SIZE & NUMBER OF BEADS

PIPE WALL THICKNESS	NUMBER OF BEADS 5/32" ROD	3/16" ROD	7/32" ROD	TOTAL NUMBER OF BEADS

NOTE: FIRST PASS ONLY
REMAINING PASSES USE
COVER BEAD MAY BE MADE WITH

TABLE II. VOLTAGE & AMPERAGE RANGE

ROD DIAMETER	AMPERAGE	ARC VOLTS

EXHIBIT B

(Sample Form)

COUPON TEST REPORT

Test No.....

Location ..... Date .....
Contractor ..... Sub-contractor .....
Schedule ..... Gang ..... Inspector .....
Date ..... State ..... Head weld ..... Bell hole weld .....
Welder ..... Mark .....
Welding time ..... Time of day .....M. Temperature .....F.
Weather condition .....
Wind break used..... voltage ..... amperage .....
Make of welding machine..... Size .....
Make of rod.....
Size of reinforcement.....
Pipe mfg'r ..... Kind ....
Wall thickness ..... Dia. O.D. ..... Wt./ft. ..... Joint length.....

Bead No.	1	2	3	4	5	6	7
Size of Rod							
No. of Rods							

Coupon stenciled	1	2	3	4	5	6	7
Original Dimension: of plate							
Orig. area of plate in ^{2}							
Maximum load							
Tensile S/in. plate area							
Fracture location							

☐ Procedure ☐ Qualifying Test ☐ Qualified
☐ Welder ☐ Line Test ☐ Disqualified

Max. tensile ..... Min. tensile ..... Avg. tensile .....
Remarks on tensile .....
1 .....
2 .....
3 .....
4 .....
Remarks on Bend Tests.....
1 .....
2 .....
3 .....
4 .....
Remarks on Nick Tests.....
1 .....
2 .....
3 .....
4 .....
Test made at..... Date .....
Tested by ..... Supervised by.....

(Use back for additional remarks.)

Note: Can be used to report both Procedure Qualification test and Welder Qualification tests.

107.03 For making the necessary welder qualification tests, Company will furnish the pipe of the diameter and specifications to be used in the work and the Contractor will provide the labour, welding materials and equipment. In the event that it is found desirable to make laboratory tests of the test coupons, arrangements will be made and paid for by Company. Field coupons from the portion of the line being constructed shall be cut and tested at the discretion of the Engineer. Should the weld meet the specifications outlined in the API Specifications the cost of the cutting and welding will be borne by Company. Should the weld not meet the specifications, the cost of the testing as well as rejoining of the pipeline at the point at which the coupon was taken will be borne by the Contractor.

SECTION 108.00: PROTECTIVE COATING

108.01 These specifications are intended to cover the complete application of the "protective coating", and neither anything herein contained nor the omission of any essential provisions herefrom shall be construed to relieve Contractor of any duty or obligation necessary for the complete application of said "protective coating".

108.02 All work to be done hereunder by Contractor shall be conducted diligently, continuously, and in good faith in a thorough, careful, skillful, and workmanlike manner in full accordance with good pipeline construction practices.

108.03 The Work shall consist of hand or machine cleaning the pipe, priming with coal tar primer, applying a 3/32 inch minimum coating of coal tar enamel, applying a reinforcing glass fiber wrap, and applying a 15 pound coal tar saturated asbestos felt or exterior wrap as may be later specified by Company. Contractor shall apply protective coating materials in accordance with manufacturer's recommendations; either in a yard with stationary machines, or over the trench with traveling machines.

(a) Handling Coating Material and Coated Pipe

Coating and wrapping materials shall be hauled in such manner as to prevent injury to packages. No packages shall be dropped or thrown from trucks, and packages shall not be handled with hooks. All rolls of pipeline wrapper shall be stored on end in a dry place, kept from contact with concrete flooring, and protected from the weather. Wrapping materials shall be transported during application in covered conveyances and removed directly from the conveyances to

machines as needed. Tools or equipment shall not be piled up on top of wrappers. Any such materials which show evidence of deterioration while in Contractor's custody due to improper protection thereof by the Contractor may be rejected by Company.

Coated pipe shall be handled at all times with wide non-abrasive slings or belts, or other equipment designed to prevent damage to the coating. All such equipment shall be kept in repair so as to prevent injury to the coating. The use of tongs, bare pinch-bars, chain slings, rope slings without canvas covers, canvas or composition belt slings with protruding rivets, pipe hooks without proper padding, or any other handling equipment found to be injurious to the coating shall not be permitted. All skids used to support coated pipe shall be padded. Walking on the coated pipe shall not be permitted.

(b) Cleaning and Priming

In preparation for the application of primer, pipe shall be cleaned until free from all loose mill scale, dirt, rust, corrosion products, pipe coating, grease, moisture, existing coating, or other foreign material. Grease or heavy oil shall be removed with a volatile solvent. Loose rust, mill scale, dirt, etc., shall be removed by mechanical cleaning machine or manual means using impact wheels, knives, or wire brushing sufficiently to remove all material other than tightly adhering mill scale. Cleaning machine tools such as cutters, knives, or wire brushes shall be kept in tight contact with the pipe and shall be replaced with sharp tools when worn to the extent that good results are not obtained. All pipe shall be cleaned with a minimum of one operation of the mechanical cleaning machine or wire brushes and coated with a regular coat of Coal Tar Pipe Line Primer. The primer shall be applied manually, or by a mechanical brushing machine (immediately after the cleaning operations) in a thin, uniform coating, and covering the entire surface of the pipe. Any uncoated places revealed by inspection shall be recoated immediately; any flooded areas or coating applied on improperly cleaned pipe shall be cut down to the surface of the pipe and recoated. Application of primer during a rain or when pipe is wet or frosted shall not be permitted. Before drawing from drums, the primer shall be agitated or stirred to insure uniformity. After drawing the quantity required, the bungs of drums shall be immediately replaced to prevent entrance of dirt or rain water, or loss of solvent. Primed pipe shall not be lowered to dirty skids. All pipe which has accumulated an excessive coat of dust before the primer is dry; or, which has been exposed to the weather for

more than 48 hours after priming to the extent that it has become "dead", shall be reprimed before application of the enamel.

(c) Preparation of Enamel

The enamel shall be broken on floors or in bins into lumps not exceeding 75 lbs. for heating. Care shall be exercised to protect the broken enamel from grass, weeds, dirt, rain or snow, or other contamination before it is charged into the heating kettles.

Suitable kettles shall be supplied. After reaching application temperature the enamel shall be used up within the same day. Kettles shall be kept clean and free of residual or all foreign matter. The kettle shall be maintained in good working order at all times, so as to be capable of providing uniformly heated and stirred enamel to the coating and wrapping machines at all times.

Strainers shall be set between kettle draw off cocks and metal hose. Strainers shall have mesh of 1/16 inch and shall be cleaned or renewed as often as required.

(d) Application of Enamel

The enamel shall be applied at the temperature specified by the manufacturer, adjusted in the field to meet the conditions, to provide a minimum thickness of 3/32 inch of enamel next to the steel. Maximum allowable temperature of the enamel shall be as specified by the manufacturer.

The enamel shall be applied by combination coating and wrapping machines in thickness of not less than 3/32 inch exclusive of the thickness of wrappers.

Coating machines shall be capable of applying enamel in a continuous coat free from bubbles or other defects. Machine operators shall be capable of operating the coating and wrapping machines so the enamel shall be applied without bubbles or other defects. Inefficient machines or operators shall be immediately replaced.

The enamel shall be applied over clean, dry, properly primed pipe surfaces, and shall be securely bonded to the primer at every point.

(e) Application of Wrappers

Immediately following application of the enamel and before the enamel is cold, the pipeline wrappers shall be applied over the enamel in a uniform spiral wrap with a double wrap spiral wrapping machine. The overlap at the edges of the wrappers shall not be less than 1/2 inch and not more than one (1) inch. No wrinkling in the wrappers shall be allowed, and all end laps shall be cemented down with hot enamel to secure a firm wrapping. All torn, abraded, or mutilated spots in the pipe coating shall be repaired in accordance with the above specifications.

SECTION 109.00: LOWERING AND BACKFILLING

109.01 All brush, skids, pipe, pipe protectors, rocks, large clods, sticks, projecting rocks, and other hard objects shall be removed from the bottom of the trench into which the coated and wrapped pipeline is to be lowered so that the protective coating shall not be punctured or abraded. The trench shall be made wide enough where slack loops are lowered into the trench so that no coating is rubbed off the sides. Whenever the bottom of the trench contains projecting rocks which might puncture the protective coating, the bottom of the trench shall be padded with a minimum of four (4) inches of backfill material free of protrusions that might damage the coating. The coated and wrapped pipeline, except for slack loops which shall be supported by wide nonabrasive belts or slings or by padded timbers in sufficient number that the pressure at the point of support shall not cause puncture of the coating, shall be lowered to the smooth bottom of the trench immediately after the coating and wrapping have been applied. Wide nonabrasive slings or belts shall be used in all lowering of the pipeline. The Contractor shall lower said line in such a manner as to provide sufficient slack in said line. The line shall not be dropped or subjected to jar or impact. Slack loops which have been supported on padded timbers shall be lowered in the early morning or at night when the pipe is cool. All coated and wrapped pipe which has been supported in any manner on padded timbers or lowering-in devices shall be subjected to close inspection to see that the coating is undamaged before the pipe reaches the bottom of the trench, and if found damaged, shall be patched.

109.02 Pipe shall normally be lowered into the trench immediately behind the coating and wrapping machines. A Holiday Detector shall be run over the pipe as it is cradled into the trench, and all flaws indicated shall be repaired before lowering. If it is necessary to return pipe to

skids after coating but prior to lowering in, such skids shall be well padded to prevent damage to the pipe coating. After the pipe is lifted from the skids preparatory to lowering in the trench, repairs to the coating shall be made if a Holiday Detector indicated a flaw in the coating. Pipe shall be laid straight into the bottom of the trench and slack loops retained on skids, depending on the location and number of bends.

109.03 Contractor shall backfill the trench as soon as practical after lowering in so as to anchor the pipe in the ground and not expose the coating to excessive temperatures or inclement weather. Slack loops shall be lowered in the morning or at night when the pipe is cool and shall not be forced into the trench, excessive slack shall be removed by cutting out sections and rewelding the pipe ends as may be necessary. Coating shall be replaced where sections are cut out in slack loops. All backfill shall be crowned a minimum of eight (8) inches above the adjacent ground.

109.04 Backfilling of all roads and highways shall be performed immediately after pipe is laid and shall be made safe for vehicular traffic. All backfilled areas shall be maintained by Contractor until testing of the particular section has been completed.

109.05 In sloping areas where there is danger of the backfill washing out in the trench, effective breakers against such washouts shall be installed. This shall be done with no extra payment to the Contractor.

109.06 Pipe anchors shall be installed as directed by Company where there is need for restraint before the backfill compacts. Installation shall conform with Exhibit I .

SECTION 110.00: CLEAN-UP

110.01 As soon as the pipe is laid and backfilled, the Contractor shall, without extra charge to Company, clean the rights-of-way and any additional areas used by him in any phase of the work, in a satisfactory manner. In the performance of this work, the following shall be observed:

(a) The cleaning up operations are to be conducted by a clean-up crew organized by the Contractor at the time he starts backfill operations and are to be diligently prosecuted, until the completion of the job.

(b) As soon as the backfill is completed, the Contractor shall immediately clean up the construction right-of-way, removing to predesignated areas all refuse, brush, stumps, broken skids, etc., to the satisfaction of Company.

(c) In cultivated farm land, permanent pasture or improved lands, the soil shall be thoroughly disked on completion of clean up.

(d) Where the line has crossed lawns, yards, or driveways, the lawns shall be resodded, and shrubbery replaced, yards and driveways shall be finished to the satisfaction of the Company.

(e) All creek and stream banks shall be restored to their former condition and properly rip-rapped so that they shall not wash out before setting.

(f) All terraces, drainage ditches, drain tile, etc., shall be restored to useable condition.

(g) All fences cut shall be restored to a condition at least as good as they were originally.

(h) All private roads used by the Contractor shall be restored to a condition at least as good as they were originally.

(i) Construction material, or defective material, shall be hauled at the Contractor's expense, to Company's nearest storage point.

(j) Clean-up operations are to be kept as close as practicable to the lowering-in operation.

SECTION 111.00: BLOCK GATE INSTALLATION

111.01 Block gate valves shall be installed at locations indicated on Exhibit H. Contractor shall make cold bends in the field in order to obtain the desired elevation of the pipe immediately adjacent to the gate valves. Installations shall be made as shown on Exhibit L.

SECTION 112.00: PUMPING STATIONS

112.01 Detailed engineering drawings shall be given to the Contractor by Company's construction office. These drawings explicitly define the construction and installation to be carried out at each of the pumping station and terminal sites. No deviations from the drawings shall be permitted without prior knowledge and concurrence of the Engineer.

112.02 If any discrepancies, errors, or omissions are found in the drawings, the Contractor shall immediately inform the Engineer. The Engineer shall make whatever study is required and instruct the Contractor as to the procedure to be followed.

112.03 The Contractor shall clear and grade sites to the levels shown on the drawings. Finished grading shall be uniformly pitched in order to present a pleasing appearance and insure adequate drainage. If fill earth must be brought to the site, or excess earth is to be disposed of, the Contractor shall obtain and follow instructions from Company. Land immediately outside of the property fences shall be leveled off or graded to blend into existing ground contours.

112.04 Excavations for footings, foundations, piers, and tanks shall be made at the locations indicated on the drawings. The Contractor shall exercise care to avoid making excavations deeper than required. Excavations shall be leveled off to the proper depth so that concrete can be poured on undisturbed earth. Backfill shall be tamped in thin layers, using water if necessary, in order to prevent future settlement. Backfill shall not be placed on or against concrete until the concrete has attained sufficient strength.

112.05 The Contractor shall prepare all forms required for pouring concrete. Forms shall be leveled, squared, and braced so movement cannot occur while concrete is being poured. Reinforcing steel shall be placed in the forms as shown on the drawings and mechanically held in position so that displacement cannot occur while concrete is being poured.

112.06 The Contractor shall use only sufficient water in concrete mixes to produce rubber plastic mixtures which flow sluggishly and can be conveyed from the mixer to the forms without a segregation of the coarse and fine aggregate. Concrete shall be deposited in final position as soon as practicable after mixing and shall be thoroughly worked around the reinforcement and into all recesses. Surface troweling, where required, shall be done at the time of pouring.

112.07 The Contractor shall test and adjust each piece of machinery and equipment installed in the pumping stations and terminal. Each piping system shall be tested to insure freedom from leaks. The electrical systems shall be tested before applying full generator voltage in order to detect any defective connections or insulation.

SECTION 113.00: GROUND AND AERIAL MARKERS

113.01 The Contractor shall install milepost markers and public warning signs furnished by Company in accordance with Exhibits F and G. These markers shall be installed on each side of every roadway and railroad crossing, and where otherwise directed by Company. Aerial markers shall be installed at each mile or as near as possible thereto.

SECTION 114.00: RAILROAD AND HIGHWAY CROSSINGS

114.01 Where the pipeline crosses a railroad or principal highways, the crossing shall be made with regular line pipe of wall thickness called for in that particular section of the line.

114.02 Cased crossings shall be installed with vents and Williamson Type Z or equal casing bushings and insulators in strict accordance with the Railroad Company's or Highway Department's requirements and specifications, and in accordance with the requirements of Exhibit C for highway crossings and Exhibit B for railroad crossings, which form a part of these Specifications. At all such crossings there shall be a minimum covering over the top of the casing of thirty-six (36) inches measured from the lowest elevation in the crossing.

114.03 Railroad and highway crossings shall be bored and cased, or cut and cased, in a manner which will meet all the requirements of the railroad, municipal, Provincial and State authorities. Care shall be taken not to block traffic while installing such crossings at railroads or principal highways.

114.04 All cased crossings shall be laid straight so that the carrier pipe may be replaced at a later date if such becomes necessary, without it being necessary to disturb the casing.

114.05 On all road crossings where casing is not required, the pipe shall be laid straight with no side bends, overbends, or underbends as these uncased roads might require casing at a later date.

SECTION 115.00: SWAMP AND MUSKEG CROSSING

115.01 In cases where swamps and muskegs are encountered along the pipeline route, the pipeline trench shall be opened by means of blasting, drag line excavation, or any other practical means acceptable to the Engineer. The pipe shall then be pushed or pulled into the trench.

115.02 In such locations the Contractor shall be permitted to clear the right-of-way to a minimum width required for construction operations and to permit trenching operations.

115.03 The pipe shall be weighted in accordance with the instructions of the Engineer. Placing of reinforced concrete coating, concrete or cast iron weights, shall be paid for on a unit basis as agreed to in the Contract.

115.04 The Contractor shall consider these swamp and muskeg crossings in his bid and they shall not be considered extra to the contract price except for the coating or placing of weights.

115.05 In every instance where a crossing of this nature occurs, the approval of the Engineer must be obtained as to the method and procedure in making the crossing.

SECTION 116.00: RIVER, CREEK AND STREAM CROSSINGS

116.01 Contractor shall adhere to the specifications and methods set forth in Exhibit D. It should be noted that the top of the pipe shall be thirty-six (36) inches minimum below the deepest part of the river bed and shall be installed as near level as practicable throughout the width of the channel where rock formations do not exist. Where rock formations exist in the river bed, the pipe shall be laid to the contour of the river bed, thirty-six (36) inches minimum depth below the river bed. On the minor rivers and streams having solid rock bottoms with only a transient covering of sand, the trench shall be blasted into the rock as though the surface of the rock were the grade level. The line shall follow the general profile of the river crossing in such instances, with the trench conforming to the specifications as set forth above for rock.

116.02 The Contractor shall use whatever means he chooses to make the installation, whether by use of dredging, dragline, hoeing, or drilling and blasting.

SECTION 117.00: TESTING

117.01 Major sections of the pipeline shall be tested upon completion of laying and backfilling as directed by the Engineer. Company shall furnish oil under adequate pressure or water at adequate pressure as the case may be, pipe, pipe fittings, valves, scrapers, and the necessary supervisions. Contractor shall furnish labour, trucks, welding equipment, and such other expendable materials and supplies as may be required to pig the lines, make said tests, and to repair or replace faulty or defective material or work.

117.02 Test pressures, testing media, plans, methods and sequence of testing procedure shall be established by the Engineer. Test pressures shall be held for a period to be specified by the Engineer, not to exceed twenty-four (24) hours. Should a significant drop in pressure occur during that period, Contractor shall locate and repair any leaks. After repairs have been made, the test shall be repeated until the section under test has been determined to be satisfactory. Company shall be responsible for the cost of all repairs attributable to defective Company furnished materials; Contractor shall be responsible for the cost of all repairs attributable to faulty workmanship on the part of Contractor.

117.03 The Company may require hydrostatic tests on sections of pipe crossing rivers, swamps, or railroads where in the opinion of the Engineer, a failure in the pipe welds would be dangerous to the public, or would be difficult or impractical to repair after the installation had been completed.

117.04 In addition to the pressure tests, the section under test shall be pressurized, then cleaned by passing a pipeline scraper through the entire section. If any scraper stops during a test run, Contractor shall cut the line and repair the opening without charge or expense to Company.

SECTION 118.00: INTENT AND SCOPE OF SPECIFICATIONS AND DRAWINGS

118.01 All work called for in the Specifications and not shown on drawings furnished hereunder by Company or shown on any such drawings and not called for in the Specifications, shall be performed by the Contractor as if described in both these ways; and should any work which is not detailed in the Specifications or such drawings be necessary to completely

construct the pipeline system ready to be operated, the Contractor shall understand the same to be implied and required and shall perform all such work as fully as if particularly described in the Specifications and such drawings, it being expressly understood that the intent of these Specifications is to provide for the construction of a pipeline system in accordance with modern pipeline practice prevailing in the industry.

2. APPENDIX

2. APPENDIX

(a) Construction Exhibits

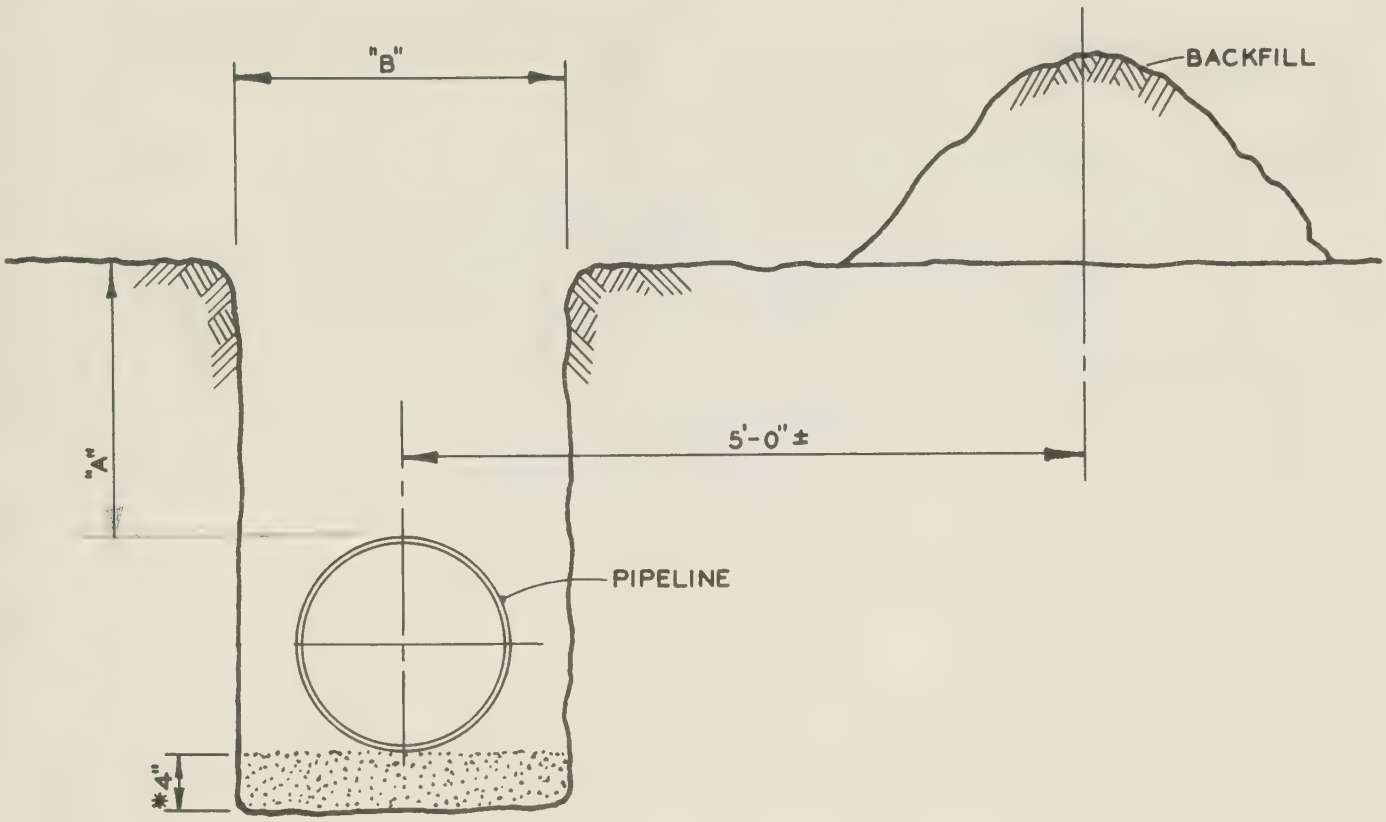
(b) Procedures for Surveys, Mapping and Acquisition of Rights-of-Way

(a) CONSTRUCTION EXHIBITS

Exhibits A through N on the following pages show proposed main line construction details. The titles of these exhibits are listed below. These exhibits are also presented in Volume I.

List of Construction Exhibits

No.	Title
A.	Minimum Ditch Requirements
B.	Specifications for Railroad Crossings
C.	Specifications for Highway Crossings
D.	Specifications for River Crossings
E.	Specifications for Electrolysis Test Stations
F.	Specifications for Aerial Markers
G.	Highway and Railroad Pipeline Markers
H.	Schedule of Main Line Gate Valves
I.	Specifications for Anchor Rods
J.	Specifications for Tile Repair
K.	Casing End Closure "Z" Gasket Installation
L.	Main Line Gate Valve Installation
M.	Details of Gate Installations
N.	Specifications for Insulating Flanges



* 4" LOOSE EARTH PADDING REQUIRED IN BOTTOM OF DITCH FOR ROCK EXCAVATION WHERE NECESSARY.

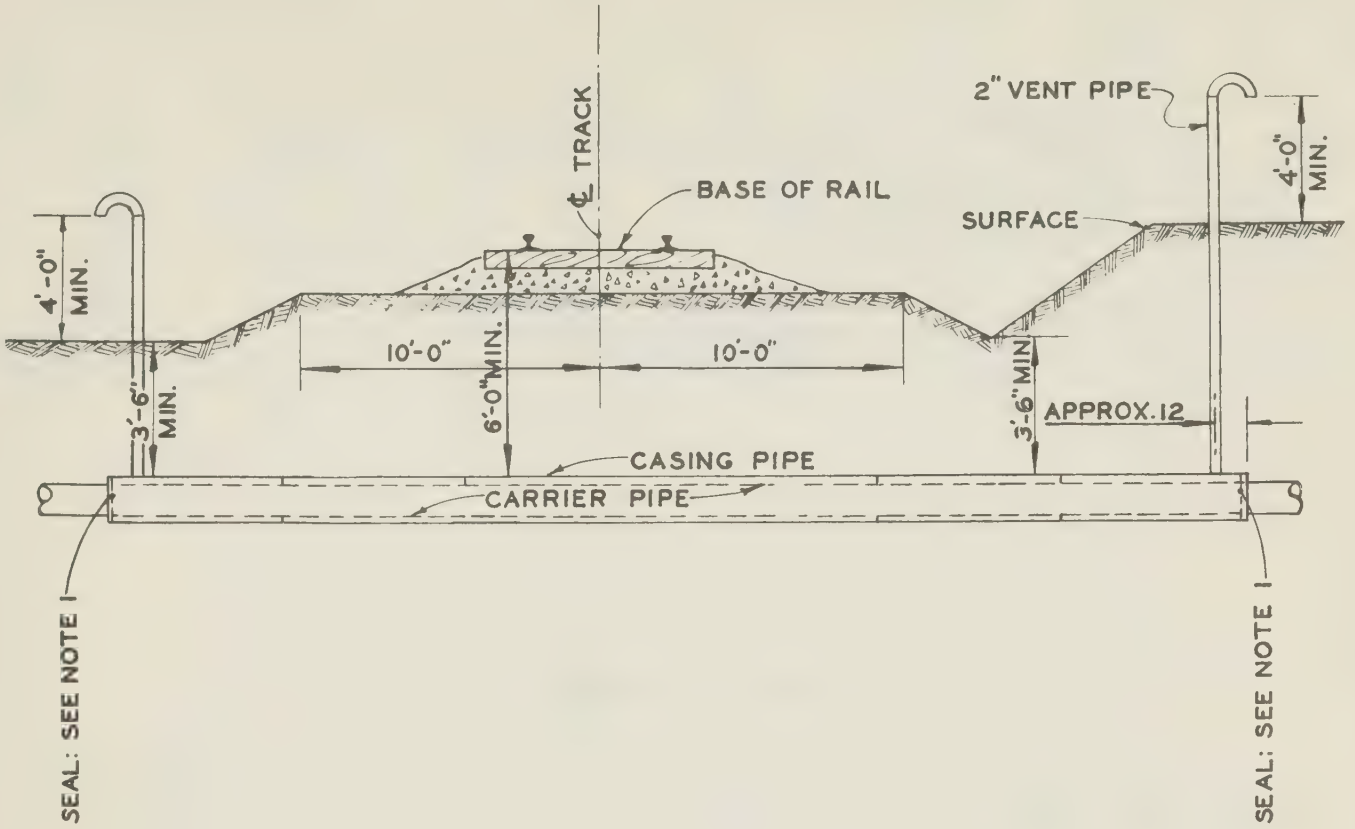
PIPE DIA.	MIN. DIM. "A" IN EARTH	MIN DIM. "A" IN ROCK	MIN. DIM. "B" EARTH OR ROCK
16"	36"	20"	26"
18"	36"	20"	28"
20"	36"	20"	30"
26"	36"	20"	36"
30"	36"	20"	40"
34"	36"	20"	44"

DUTTON - WILLIAMS BROTHERS LIMITED
ENGINEERS — CONSTRUCTORS
CALGARY, ALBERTA

MINIMUM DITCH REQUIREMENTS

DRAWN ROGERS | DATE 2 - 1 - 58 | CHECKED C. B. D. | EXHIBIT A

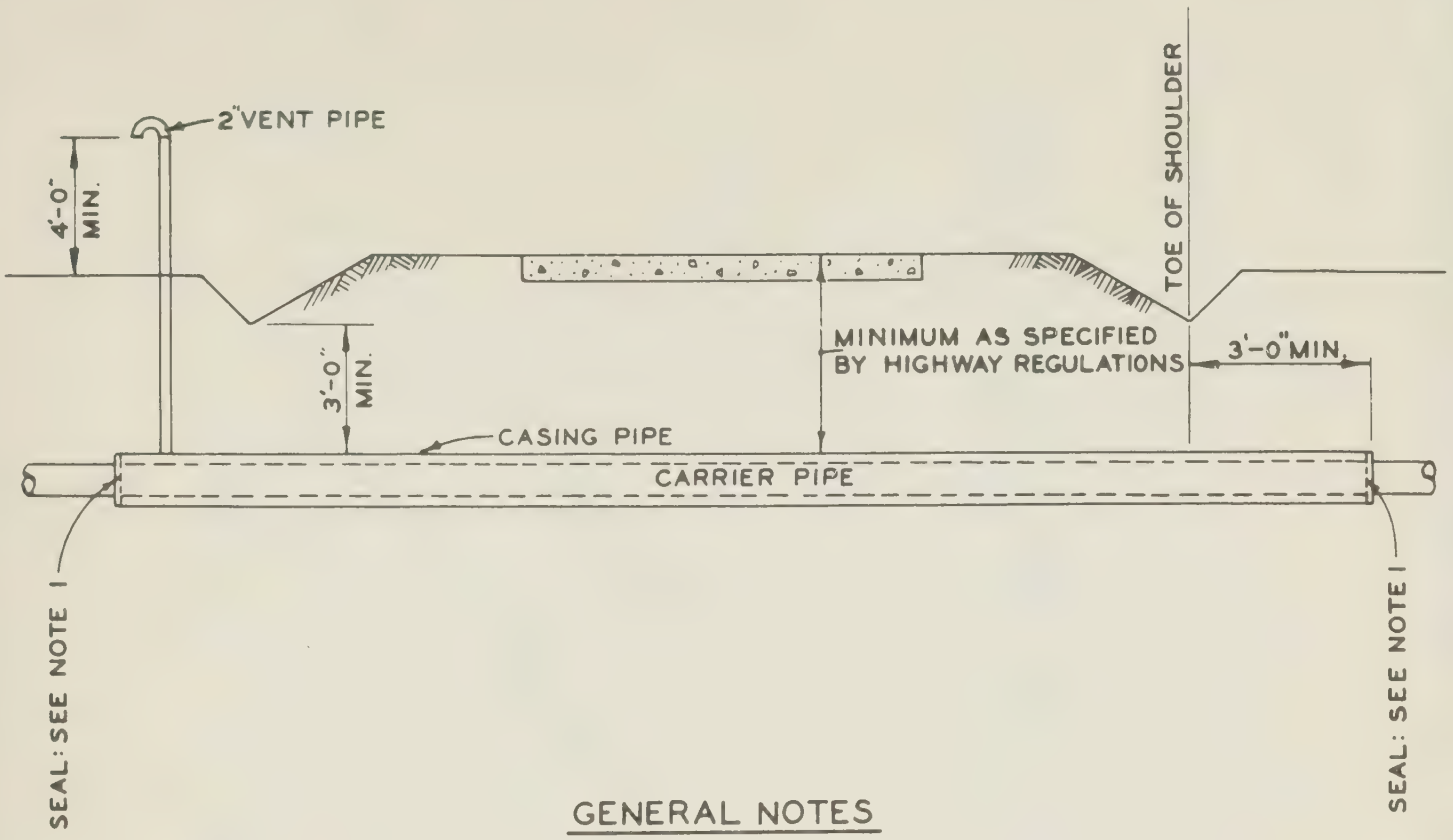
TRACED | SCALE NONE | APPROVED C. J. F.



GENERAL NOTES

1. SEAL CASING BUSHING, WILLIAMSON TYPE Z, EACH END.
2. PIPELINE SHALL NOT BE CONSTRUCTED UNDER RAILROAD RIGHT OF WAY AND TRACKS NEARER THAN SIX (6) FEET ON A LINE PERPENDICULARLY DISTANT FROM ANY RAIL JOINT IN SAID TRACK.
3. CASING PIPE SHALL BE PLACED UNDER ROADBED AND TRACKS BY THE JACKING OR BORING METHOD IN ALL CROSSINGS UNDER THIS PARTICULAR SPECIFICATION UNLESS INSTRUCTIONS TO THE CONTRARY ARE ISSUED BY THE COMPANY. THE TRENCH ON EACH SIDE OF THE TRACK SHALL BE PROMPTLY REFILLED IN A PROPER AND WORKMANLIKE MANNER. SO AS TO LEAVE NO HOLES OR OBSTRUCTIONS THEREIN AND SO AS TO FURNISH AND PROVIDE PROPER DRAINAGE.
4. WHERE, IN THE OPINION OF THE RAILROAD COMPANY'S CHIEF ENGINEER, DRAINAGE DITCHES OR OTHER CONDITIONS REQUIRE THE PIPE AND CASING TO BE BURIED TO A GREATER DEPTH, PIPE SHALL BE SO INSTALLED.
5. NO PIPE SHALL BE PLACED ON, UNDER, OR WITHIN 25 FEET OF, ANY BRIDGE, CULVERT, OR STRUCTURE, WITHOUT SPECIAL AUTHORITY OF RAILROAD COMPANY'S CHIEF ENGINEER.
6. CASING PIPE SHALL BE $\frac{3}{8}$" WALL WITH AN OUTSIDE DIAMETER 4" GREATER THAN THAT OF THE MAIN LINE PIPE.
7. IN ALL CASES THE SPECIFICATIONS OF THE OF THE RAILROAD COMPANY WHOSE FACILITIES ARE BEING CROSSED SHALL GOVERN.

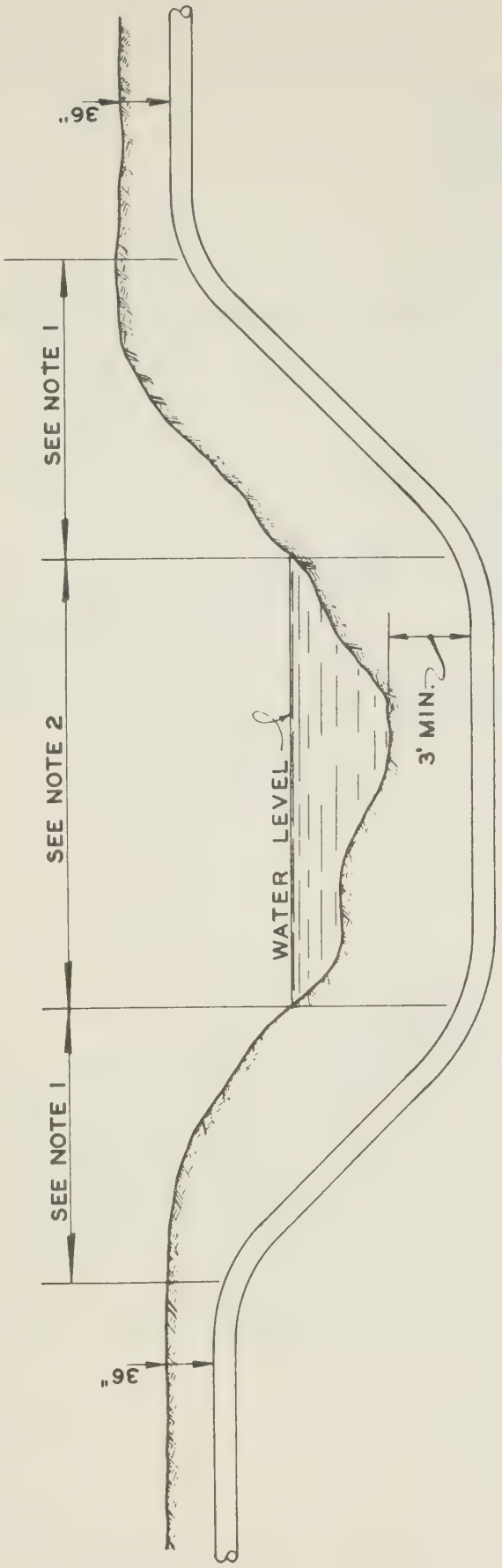
DUTTON - WILLIAMS BROTHERS LIMITED ENGINEERS — CONSTRUCTORS CALGARY, ALBERTA		SPECIFICATIONS FOR RAILROAD CROSSINGS	
DRAWN ROGERS	DATE 2 - 1 - 58	CHECKED C. B. D.	EXHIBIT B
TRACED	SCALE NONE	APPROVED C. J. F.	



GENERAL NOTES

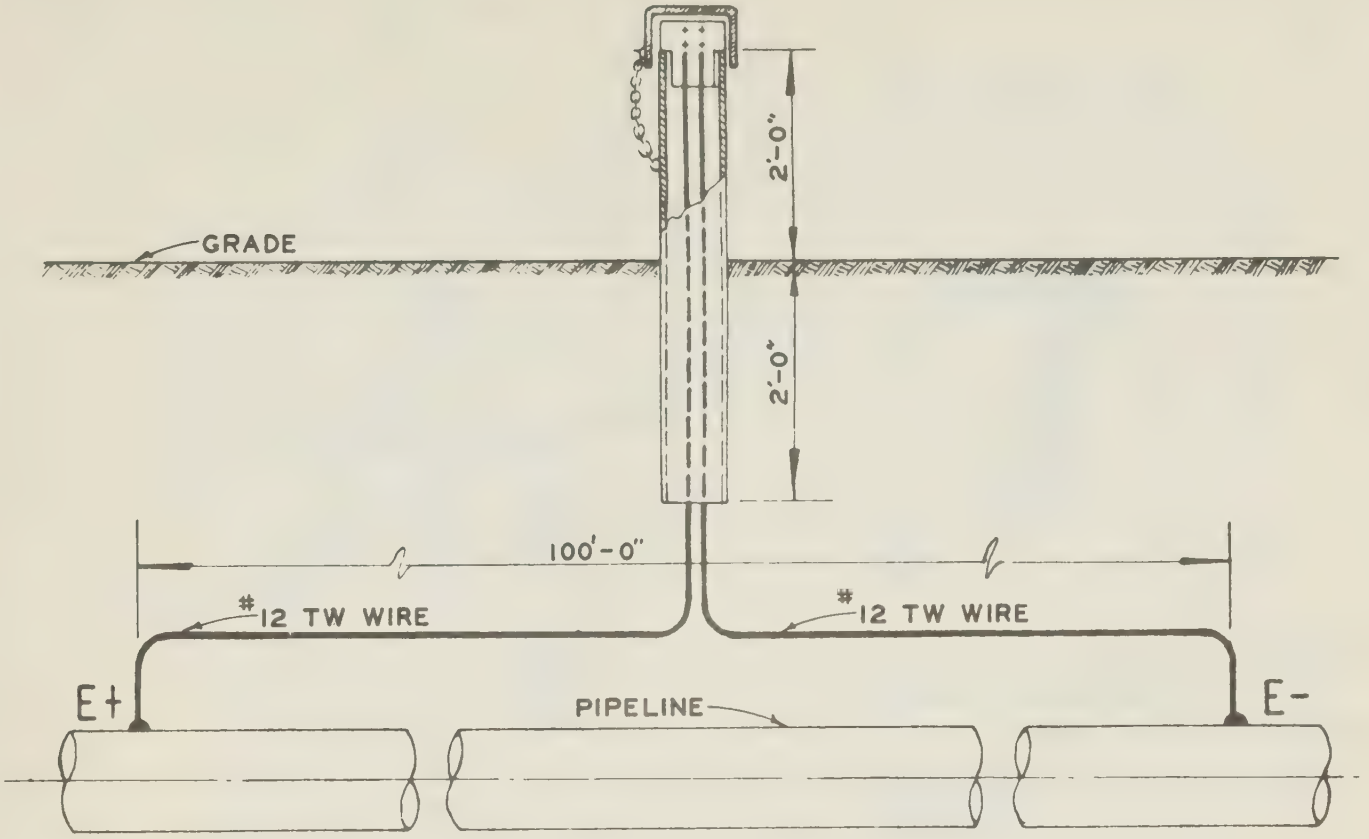
1. SEAL CASING BUSHING, WILLIAMSON TYPE Z, EACH END.
2. BORING SHALL BE DONE BY AN APPROVED METHOD AND THE CASING SHALL BE ADVANCED AT A RATE APPROXIMATELY EQUAL TO THE RATE OF BORING. WHERE BORING IS NOT PRACTICAL, DUE TO ROCK STRATA OR OTHER OBSTRUCTIONS, THE CHIEF ENGINEER OF THE DEPARTMENT OF HIGHWAYS SHALL FIRST APPROVE ALL PLANS FOR CONSTRUCTION BY "OPEN CUT", "TUNNELING", OR OTHER METHODS.
3. IN REFILLING THE TRENCH EXCAVATED FOR THE PIPELINE, ADJACENT TO HARD SURFACED ROADS OR HIGHWAYS AND ACROSS ROADS WHERE TRENCHING IS PERMITTED, THE TRENCH SHALL BE PROMPTLY BACKFILLED IN A PROPER AND WORKMANLIKE MANNER SO AS TO LEAVE NO HOLES OR OBSTRUCTIONS THEREIN AND SO AS TO FURNISH AND PROVIDE PROPER DRAINAGE.
4. CASING PIPE SHALL BE $\frac{3}{8}$" WALL WITH AN OUTSIDE DIAMETER 4" GREATER THAN THAT OF THE MAIN LINE PIPE.
5. LOCATE VENT ACCORDING TO HIGHWAY DEPT. INSTRUCTIONS.

DUTTON-WILLIAMS BROTHERS LIMITED ENGINEERS — CONSTRUCTORS CALGARY, ALBERTA		SPECIFICATIONS FOR HIGHWAY CROSSINGS	
DRAWN ROGERS	DATE 2-1-58	CHECKED C. B. D.	EXHIBIT C
TRACED	SCALE NONE	APPROVED C. J. F.	



NOTES:
1. PIPE TO BE LAID TO EXTRA DEPTH AT THESE LOCATIONS TO PREVENT EXCESSIVE BENDING.
2. RIVER PIPE TO BE LEVEL UNDER RIVER CHANNEL EXCEPT IN ROCK FORMATIONS WHERE PIPE MAY BE LAID A MINIMUM OF 3' BELOW RIVER BED.

DUTTON-WILLIAMS BROTHERS LIMITED ENGINEERS — CONSTRUCTORS CALGARY, ALBERTA		SPECIFICATIONS FOR RIVER CROSSINGS	
DRAWN ROGERS	DATE 2-1-58	CHECKED C.B.D.	EXHIBIT D
TRACED	SCALE NONE	APPROVED C.J.F.	



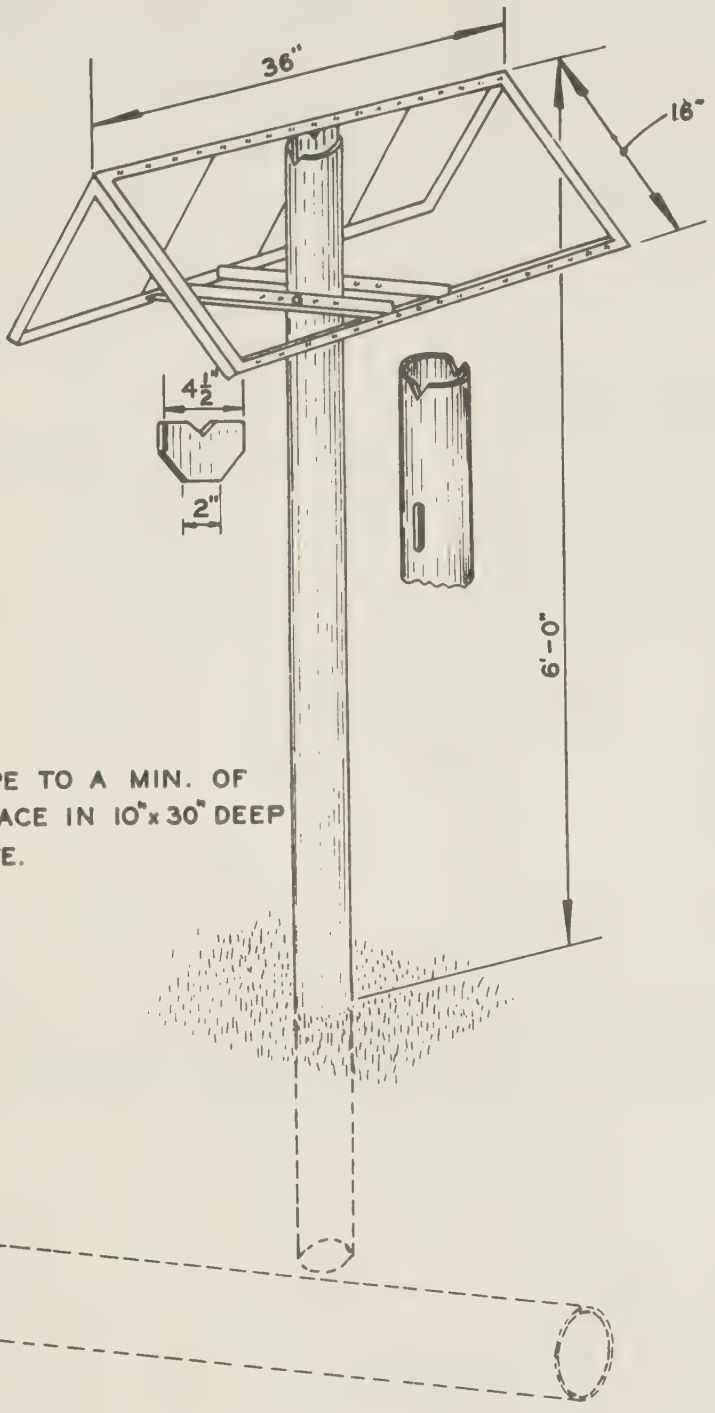
GENERAL NOTES

1. STD. WT. 2" PIPE BURIED 2' IN GROUND AND 2' ABOVE GROUND. WIRES TIED TO SERVICE ENGINEERS INC. 2 SIZE PLASTIC TERMINAL BOARD AND PIPE CAPPED WITH 2" SIZE SERVICE ENGINEERS INC. ELECTROLYSIS CHECK POINT ALUMINUM CAP WITH CHAIN SPOT WELDED OR BRAZED TO THE 2" PIPE 8" BELOW TOP OF PIPE.
2. WIRES TO BE SOLID TW COVERED #12 COPPER WIRE FURNISHED BY THE COMPANY.
3. WIRES TO BE WELDED TO PIPE BY THE CADWELD PROCESS AND INSULATED WITH ENAMEL AND ASBESTOS FELT PAPER OR ADHESIVE TAPE. MATERIAL TO BE FURNISHED BY THE COMPANY.
4. LAY WIRES IN TRENCH BESIDE PIPE, NOT UNDER OR OVER PIPE.

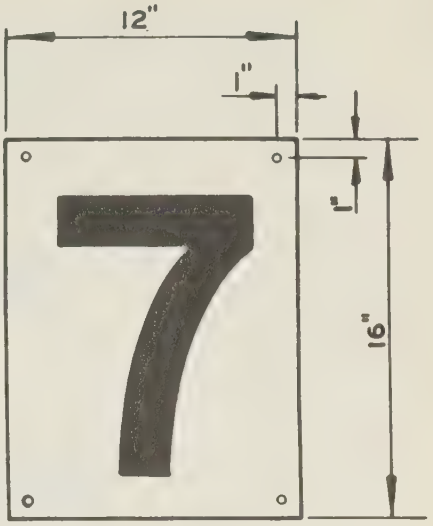
DUTTON-WILLIAMS BROTHERS LIMITED ENGINEERS — CONSTRUCTORS CALGARY, ALBERTA		SPECIFICATIONS FOR ELECTROLYSIS TEST STATIONS	
DRAWN ROGERS	DATE 2-1-58	CHECKED C.B.D.	EXHIBIT E
TRACED	SCALE NONE	APPROVED C. J. F.	

MARKER TO BE MOUNTED ON 4" PIPE.

WEDGE USED TO ATTACH TOP MEMBER.
BOLT USED TO ATTACH BOTTOM MEMBER.
ALL FRAME TO BE 1"x 1"x $\frac{3}{16}$" ANGLE.



DRIVE PIPE TO A MIN. OF 4' OR PLACE IN 10"x 30" DEEP CONCRETE.

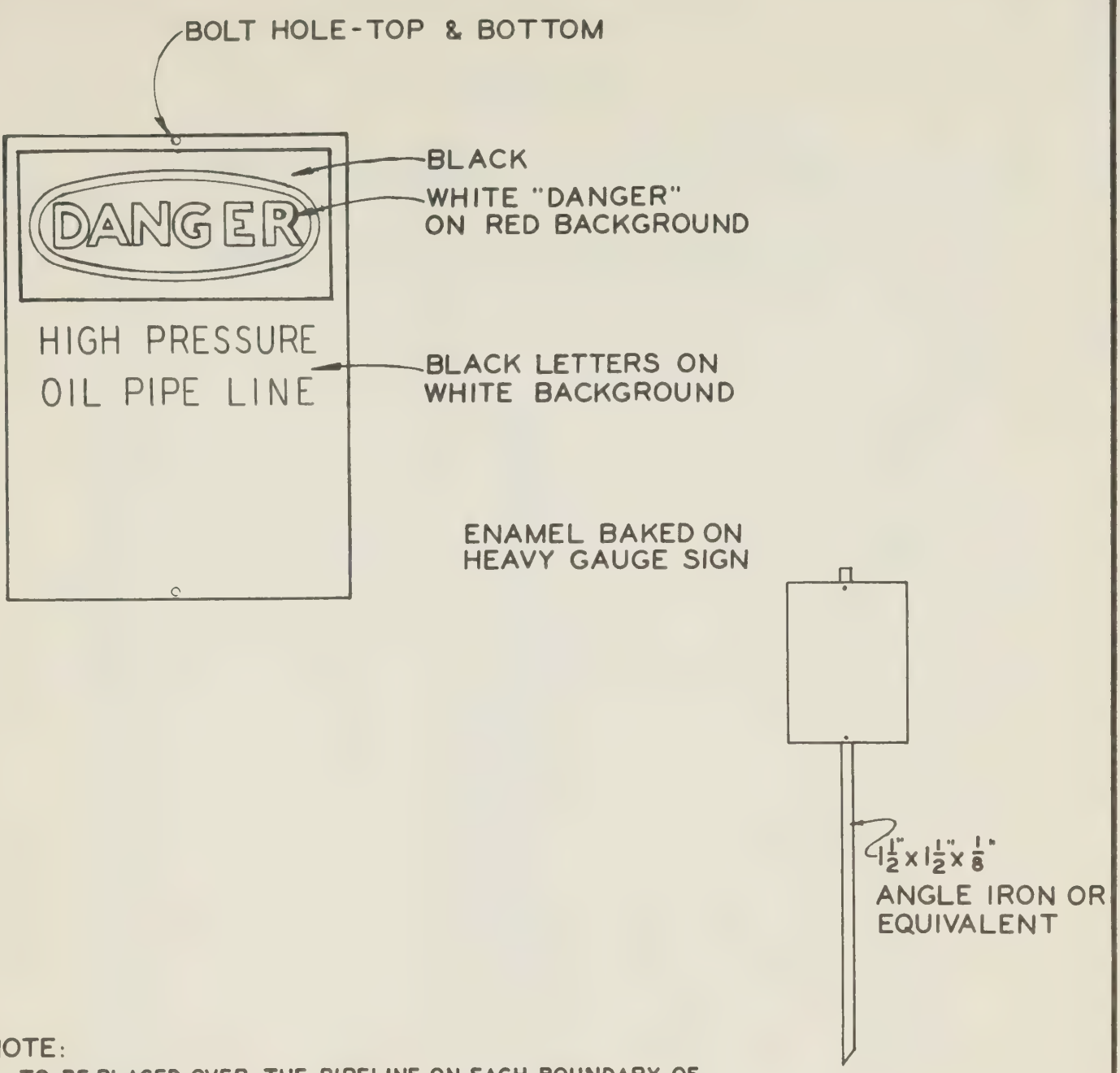


BACKGROUND COLOR TO BE BRIGHT ORANGE OR CHROME YELLOW.
ALL NUMERALS TO BE DEAD BLACK.

ATTACH NUMERALS TO ARMS WITH $\frac{1}{8}$"ϕ BOLTS.

NUMERAL PLATES TO HAVE PORCELAIN FINISH. ALL OTHER METAL TO HAVE PROTECTIVE ALUMINUM COATING.

DUTTON-WILLIAMS BROTHERS LIMITED ENGINEERS — CONSTRUCTORS CALGARY, ALBERTA		SPECIFICATIONS FOR AERIAL MARKERS	
DRAWN ROGERS	DATE 2-1-58	CHECKED C. B. D.	EXHIBIT F
TRACED	SCALE NONE	APPROVED C. J. F.	



NOTE:
TO BE PLACED OVER THE PIPELINE ON EACH BOUNDARY OF EACH HIGHWAY, PUBLIC ROAD, OR RAILROAD RIGHT OF WAY.

DUTTON-WILLIAMS BROTHERS LIMITED ENGINEERS — CONSTRUCTORS CALGARY, ALBERTA		HIGHWAY AND RAILROAD PIPELINE MARKERS	
DRAWN ROGERS	DATE 2-1-58	CHECKED C.B.D.	EXHIBIT G
TRACED	SCALE NONE	APPROVED C.J.F.	

EXHIBIT H

SCHEDULE OF MAIN LINE GATE VALVES

Location - Milepost Measured from Edmonton

124.3	745.0	1380.0
150.2	766.8	1424.0
176.7	810.0	1440.0
193.9	834.0	1489.6
241.2	878.0	1508.6
267.5	900.0	1549.4
293.7	923.0	1569.2
329.0	964.0	1589.3
370.5	984.0	1609.2
391.0	1003.8	1652.0
411.6	1024.5	1675.0
452.5	1068.2	1699.6
471.3	1091.9	1721.7
490.0	1112.3	1770.5
511.7	1137.5	1794.8
553.2	1180.5	1839.4
577.7	1203.0	1862.4
600.2	1223.9	1909.5
638.5	1267.3	1931.2
661.0	1290.0	1954.0
684.0	1310.4	1998.8
727.8	1355.5	

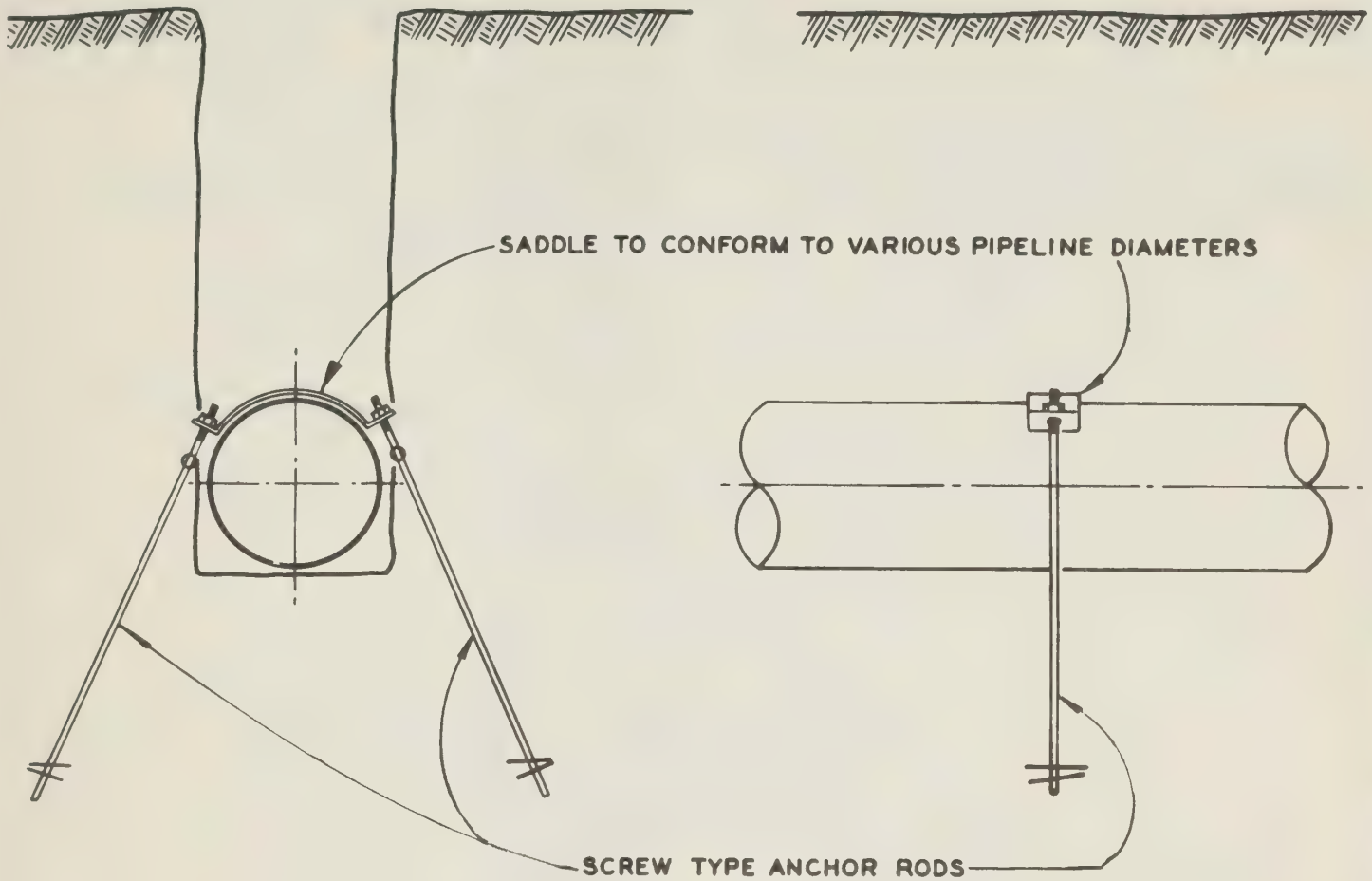
TOTAL 65 Gate Valves, Main Line

Calgary Lateral
(MP measured from Calgary)

for 10 3/4" O.D. Pipe	for 16" O.D. Pipe
14.5	93.2
31.4	114.8
43.0	
59.5	

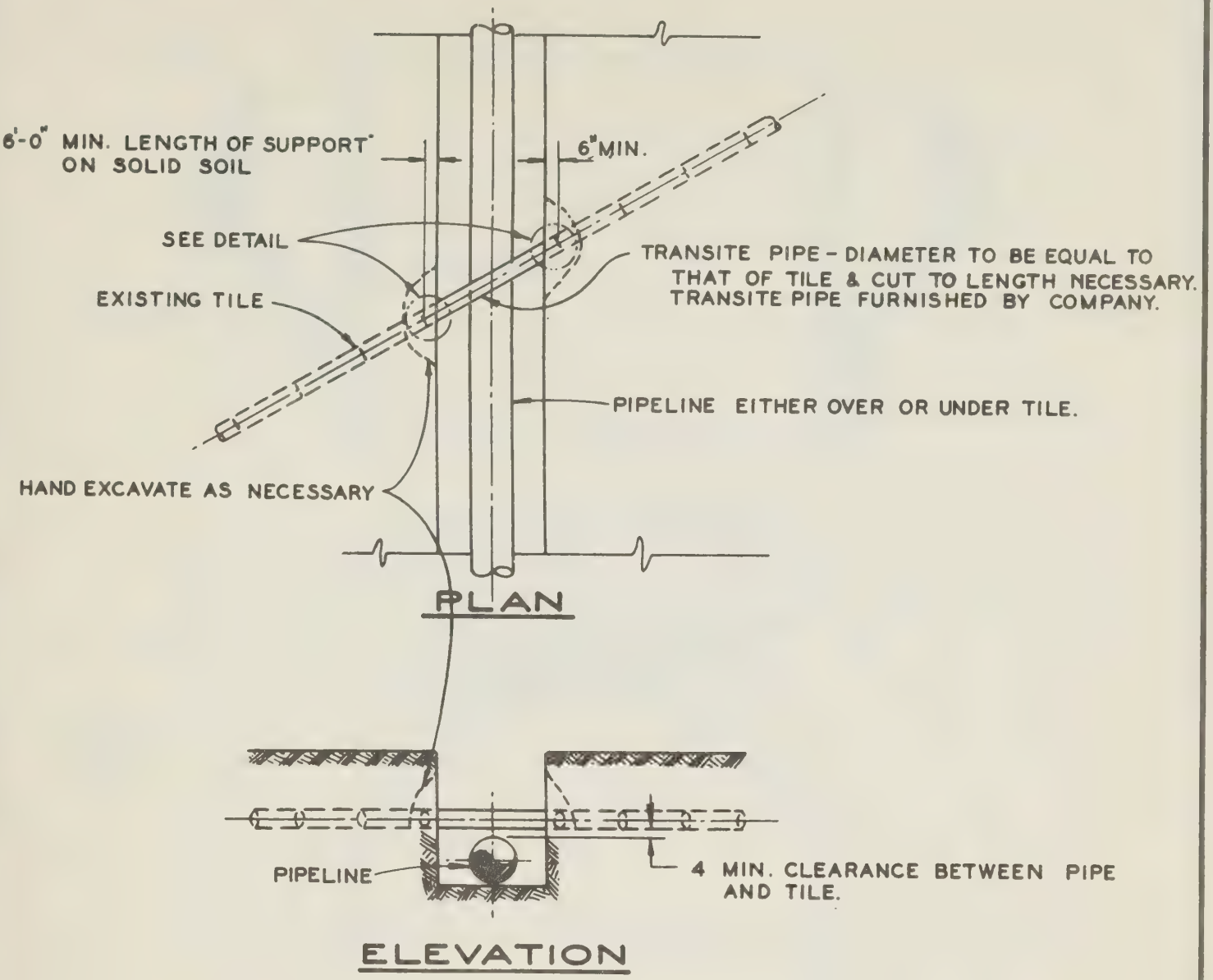
Edmonton Lateral (26" O.D. Pipe)
(MP measured from Edmonton)

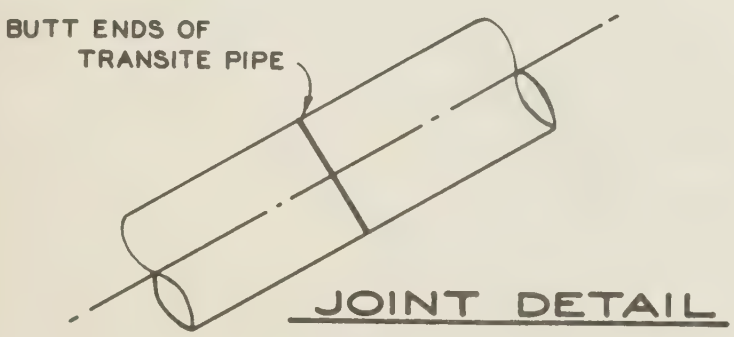
21.2
41.9
65.5
82.3



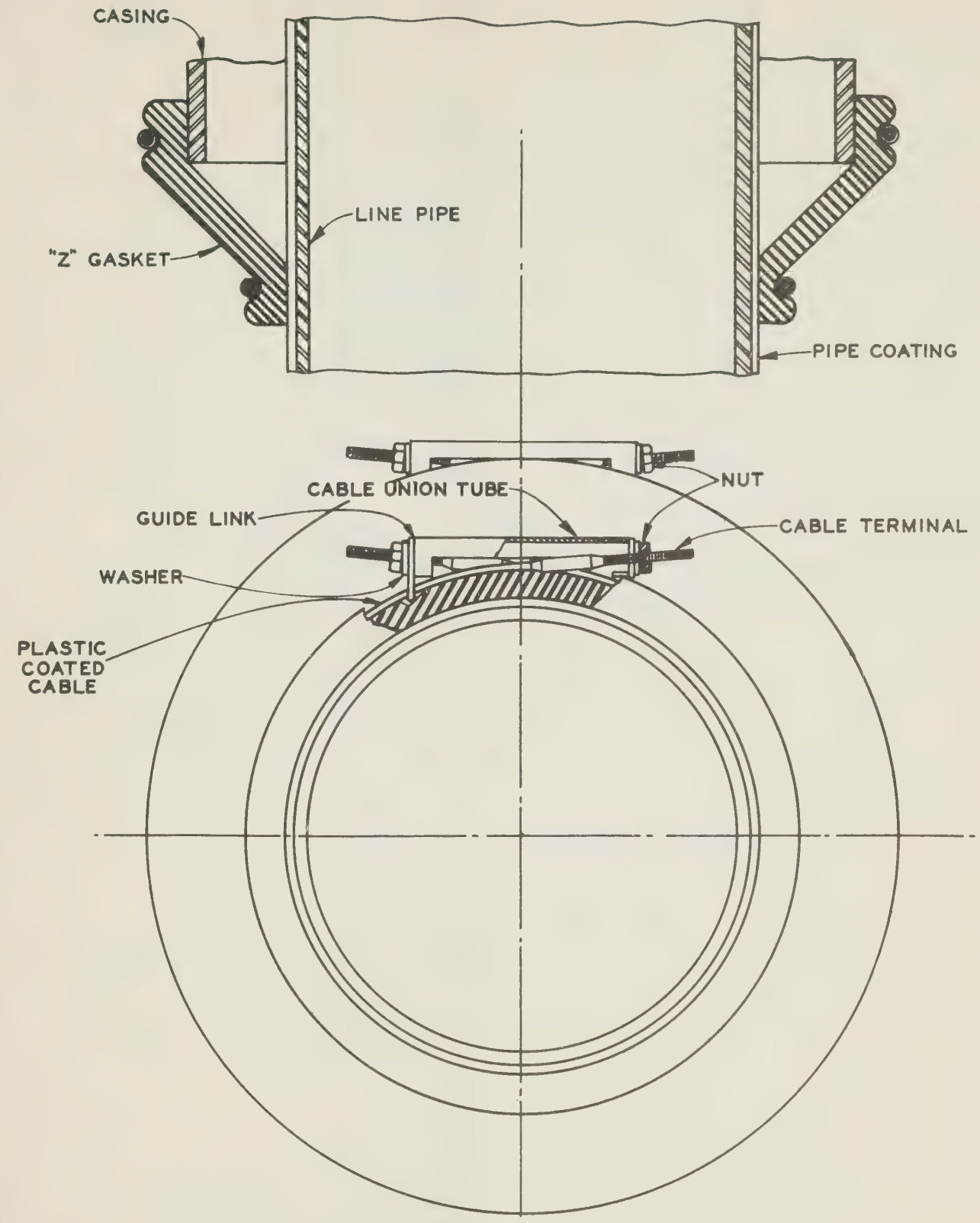
NOTE: LOCATION AND SPACING TO BE DETERMINED BY FIELD ENGINEER.
TO BE INSTALLED IN AREAS SUBJECT TO POSSIBLE INUNDATION PRIOR TO CONSOLIDATION OF THE BACKFILL.

DUTTON-WILLIAMS BROTHERS LIMITED ENGINEERS — CONSTRUCTORS CALGARY, ALBERTA		SPECIFICATIONS FOR ANCHOR RODS	
DRAWN ROGERS	DATE 2-1-58	CHECKED C.B.D.	EXHIBIT I
TRACED	SCALE NONE	APPROVED C.J.F.	

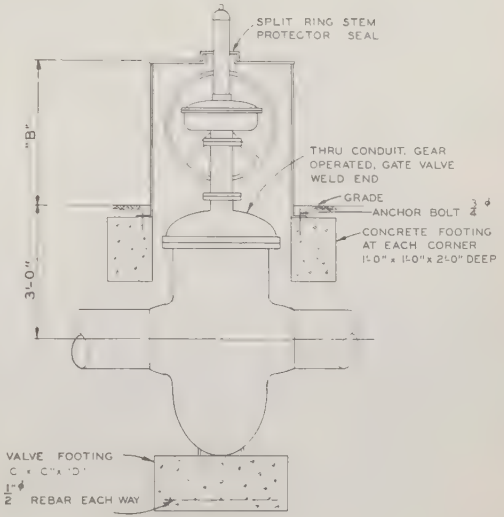


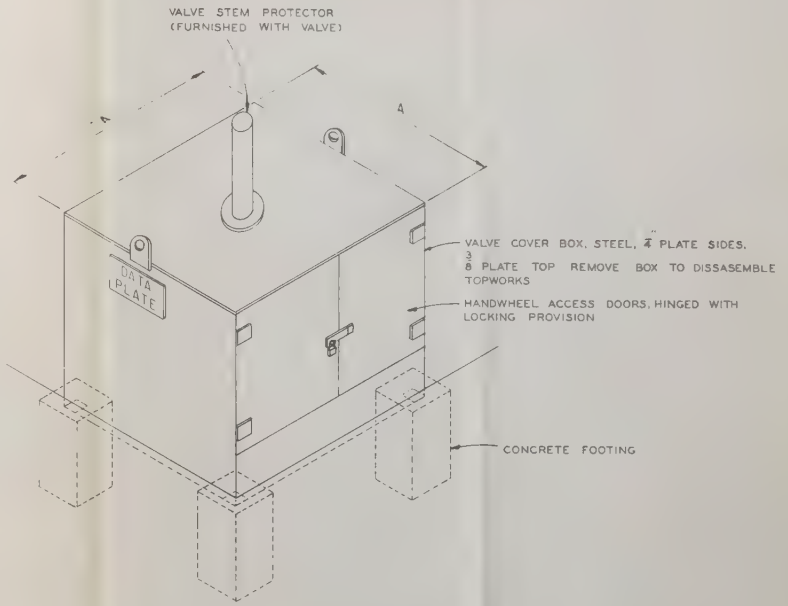


DUTTON - WILLIAMS BROTHERS LIMITED ENGINEERS — CONSTRUCTORS CALGARY, ALBERTA		SPECIFICATIONS FOR TILE REPAIR	
DRAWN ROGERS	DATE 2-1-58	CHECKED C. B. D.	EXHIBIT J
TRACED	SCALE NONE	APPROVED C. J. F.	



DUTTON-WILLIAMS BROTHERS LIMITED ENGINEERS — CONSTRUCTORS CALGARY, ALBERTA		CASING END CLOSURE "Z" GASKET INSTALLATION	
DRAWN ROGERS	DATE 2-1-58	CHECKED C.B.D.	EXHIBIT K
TRACED	SCALE NONE	APPROVED C. J. F.	





VALVE SIZE	A	B	C	D
16"	38"	41"	36"	15"
18"	38"	45"	38"	15"
20"	48"	51"	40"	15"
26"	50"	69"	46"	18"
30"	56"	78"	50"	18"
34"	60"	85"	60"	18"

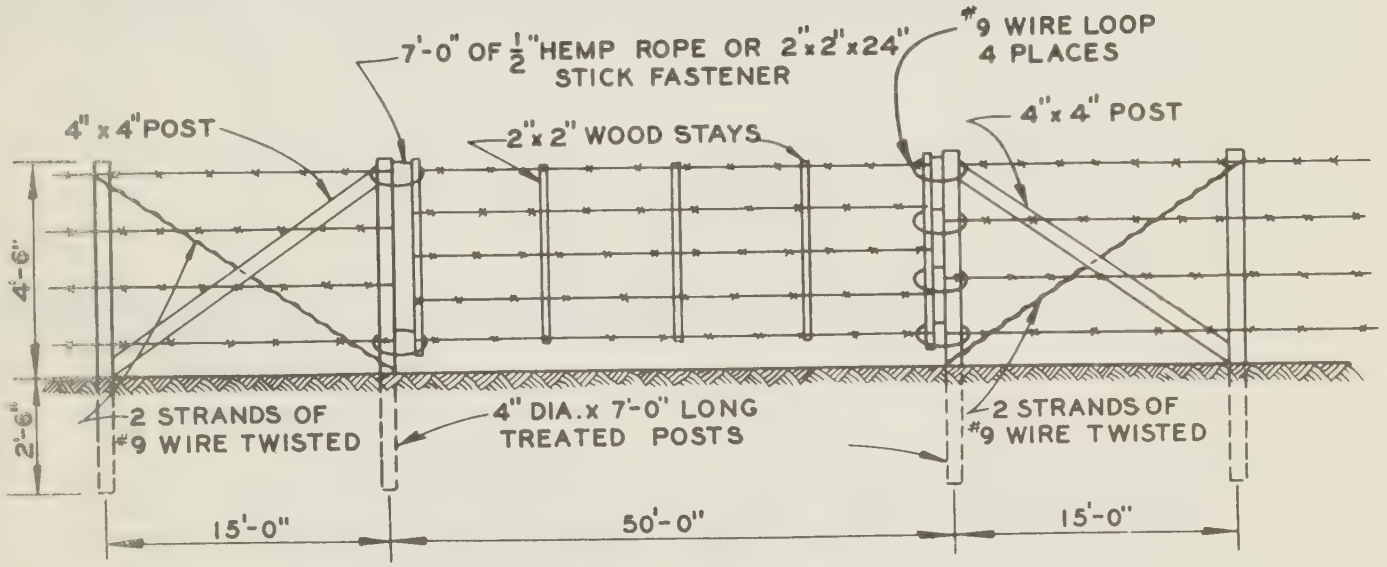
DUTTON-WILLIAMS BROTHERS LIMITED
ENGINEERS — CONSTRUCTORS
CALGARY, ALBERTA

MAIN LINE GATE VALVE INSTALLATION

DRAWN ZEVNIK | DATE 2-1-58 | CHECKED C.B.D.
TRACED | SCALE NONE | APPROVED C.J.F.

EXHIBIT L

OFFSET METHOD
TO BE USED AT CUTS

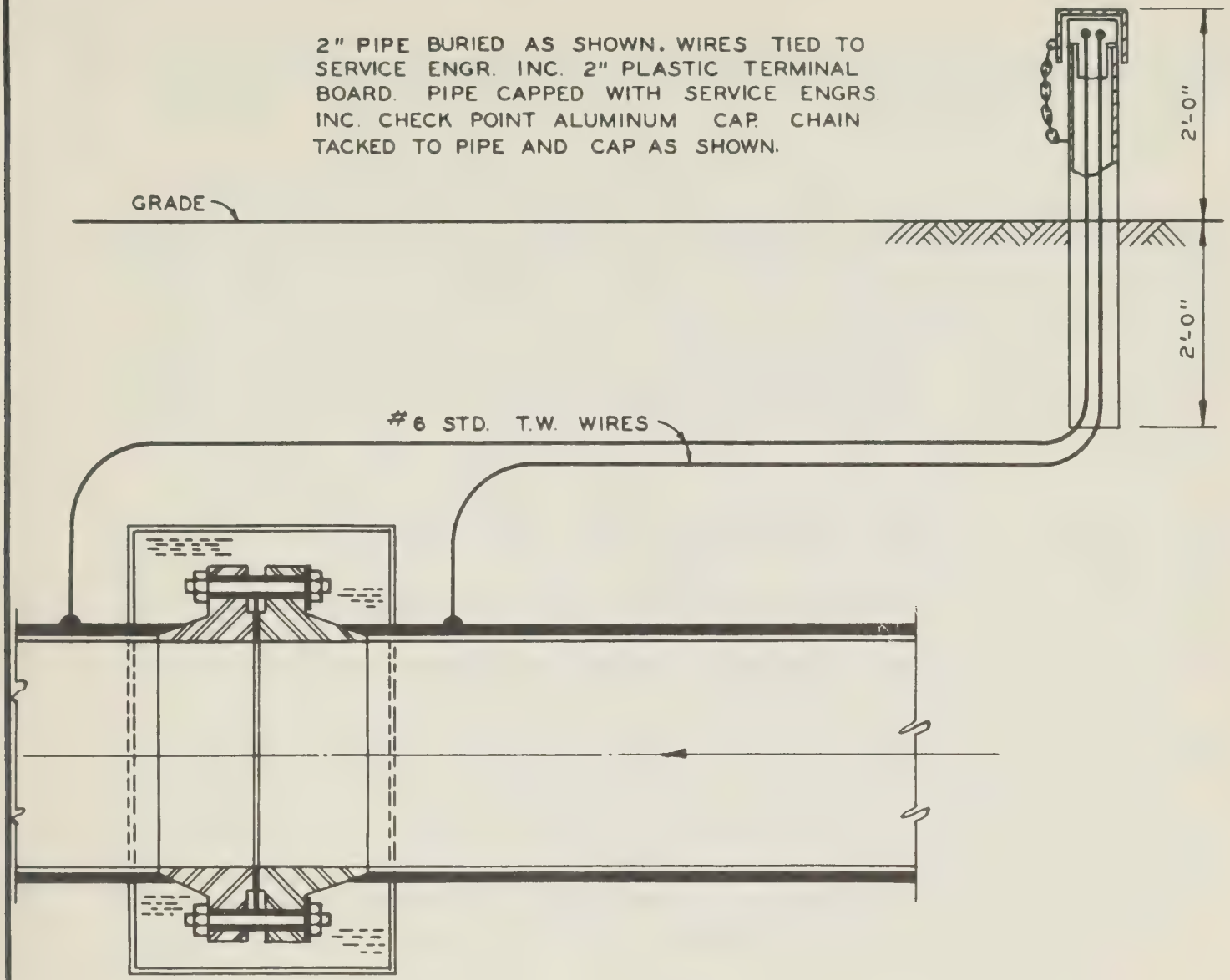


GATE INSTALLATION

NOTE: REBUILD FENCES TO ORIGINAL POST SPACING REMOVING ALL BRACES AND TIES.

DUTTON-WILLIAMS BROTHERS LIMITED ENGINEERS — CONSTRUCTORS CALGARY, ALBERTA		DETAILS OF GATE INSTALLATIONS	
DRAWN ROGERS	DATE 2-1-58	CHECKED C.B.D.	EXHIBIT M
TRACED	SCALE NONE	APPROVED C.J.F.	

2" PIPE BURIED AS SHOWN. WIRES TIED TO SERVICE ENGR. INC. 2" PLASTIC TERMINAL BOARD. PIPE CAPPED WITH SERVICE ENGRS. INC. CHECK POINT ALUMINUM CAP. CHAIN TACKED TO PIPE AND CAP AS SHOWN.



INSULATING FLANGE BOXED AND FILLED WITH PIPE LINE ENAMEL OR WAX TO COVER COMPLETELY, AFTER LINE HAS BEEN HYDROSTATICALLY TESTED.

ABOVE GROUND INSULATED FLANGES NEED NOT BE ENCASED.

COPPER WIRE CONNECTIONS TO PIPE SHALL BE THERMITE WELDED. PIPE COATING MUST BE REPAIRED AFTER WELD IS MADE.

INSULATING FLANGES ADJACENT TO VALVES NEED NOT BE ENCASED NOR WILL TEST LEADS BE REQUIRED.

LOCATIONS DEPENDENT UPON SOIL CONDITION DETERMINED PRIOR TO CONSTRUCTION.

DUTTON-WILLIAMS BROTHERS LIMITED ENGINEERS — CONSTRUCTORS CALGARY, ALBERTA		SPECIFICATIONS FOR INSULATING FLANGES	
DRAWN ZEVNIK	DATE 2-1-58	CHECKED C. B. D.	EXHIBIT N
TRACED	SCALE NONE	APPROVED C. J. F.	

(b) PROCEDURES FOR SURVEYS, MAPPING AND ACQUISITION OF RIGHTS-OF-WAY

Assume that preliminary plans for construction of the pipeline are complete. Economic and engineering studies are complete. Feasibility of the project is established. Oil is available and committed to the line for transportation. Markets are determined. The general route of the line is selected from the source of supply to terminals for delivery. Financing is arranged. Working capital is available. Pipe is on order. Shipping dates are set. Then construction can begin as soon as the line is surveyed, the right-of-way is purchased, and the maps are completed.

At this stage, field operations must begin immediately to effect economic advantage. Field engineers, right-of-way agents, surveyors, and draftsmen must start field work promptly. Actual construction must follow these initial field operations as closely as possible. Rapid completion of facilities allows financial gain in two categories--savings in working capital, and early commencement of income from transportation revenues.

In view of these possible savings and increased revenue, the work of field engineering and right-of-way departments gains a position of great significance during pipeline construction. It requires handling of seemingly endless details, never of constant pattern and inevitably time-consuming if not properly planned and executed. An efficient organization, staffed with experienced pipeline personnel, is essential. Extremely important are chronological procedures for surveys, mapping and acquisition of rights-of-way.

The following outline of procedures, used and proven on numerous pipeline projects, describes a suitable approach to the problem.

1. Obtaining and Preparing Maps for Planning

All available planning maps should be ordered early. These maps have great utility:

(a) Government Quadrangles (Topographic maps). Topographic maps, made into a strip, are excellent for preliminary reconnaissance because they show exact locations of physical features and contour elevations. Used in conjunction with photographs, they are excellent for detailed reconnaissance. They also are sources of much precise survey data.

(b) Municipal Highway Maps. Highway maps are joined together to form a strip map. The strip map is reproduced on a transparency and printed. The map serves many uses of utmost importance in a well planned operation, such as (1) a travel map by all personnel; (2) a reconnaissance map; (3) an aid in estimating casing; (4) a source of owners' names for rights-of-way and other permits to cross roads, railroads, canals, power lines; (5) a flight map for aerial photographers; (6) a progress map during surveys, mapping, right-of-way acquisition, and construction.

2. Preliminary Right-of-Way Preparations

Immediately upon completion of plans to construct a line and prior to any field work, legal counsel should be appointed and right-of-way forms prepared and approved.

The chief legal counsel should confer with the counsel of the financial backers for an opinion on the type of easement acceptable to them. He should confer with the right-of-way superintendent to obtain his opinion on the form of easement that will be most acceptable to landowners, thereby lessening the difficulties and cost of obtaining rights-of-way. Forms that are brief and easily understood are invaluable for obtaining easements quickly and for a reasonable price.

Since preparation, legal approval, and printing of right-of-way forms requires considerable time, and field work should be started when forms are available, forms should be prepared in order of their use as follows:

(1) Deeds
(2) Title Search
(3) Right-of-Way Easement
(4) Right-of-Way Draft
(5) Tenant Consent
(6) Subordination Agreement
(7) Damage Release

The chief counsel should appoint local counsel in each municipality to act as consultant on all right-of-way problems within the municipality. Though the work required of local counsel may be minimum, the presence of a respected citizen representing the pipeline owner locally is often a valuable public relations factor. Local counsel should advise local bankers and public officials of plans to construct a pipeline, to preclude accusations of "trespasser" and to further cement public relations. The landowner apparently always goes first to his banker or commissioner.

3. Acquisition of Station Sites

Station sites should be optioned or purchased prior to surveys and acquisition of rights-of-way. Otherwise, selected station sites may prove unavailable after obtaining the pipeline rights-of-way, requiring rerouting of the line to new station sites at considerable additional cost. The approximate location of pumping stations is determined by flow calculations. But exact locations must be determined before the shortest pipeline route can be selected. The locations are not exact until the sites have been optioned or purchased.

4. Preliminary Reconnaissance

The reconnaissance engineer can select a preliminary, reasonably accurate and economical route in the office, from topographic and highway strip maps, and ownership maps if available. But this route must be checked thoroughly on the ground at key points--such as station site locations, river crossings, highway and railroad crossings, mountain passes, heavily settled suburban areas. These are critical points where the line should be fixed before the proposed route is photographed. The route between critical points can be traveled by car and checked rapidly, the reconnaissance engineer pinpointing the route locations with surprising accuracy and speed preparatory to aerial photography and abstracting.

5. Aerial Photography

The pilot should be furnished a strip map for a flight map, showing the preliminary reconnaissance line. If this line were pinpointed with reasonable accuracy during preliminary reconnaissance, as recommended above, there is no need for wide-coverage photographs taken from high elevations. Photographs should be taken at around 9,000 feet to obtain at least two-mile coverage and the clarity necessary for right-of-way, surveying, and mapping purposes. Photographers should prepare one complete set of contact prints with two-thirds overlap. Contact prints for mosaics may be ratioed on an enlarger to eliminate distortion and to maintain a constant scale. The correct scale can be determined by the use of ground control or control plots prepared from government quadrangles or original township survey plats. The photographer should furnish a complete set of mosaics on five-mile sheets to scale one inch equal to 1000 feet, prepared on heavy matte photographic paper or on photographic linen.

Photographic linens can be used as base maps for all alignment mapping. They preclude the use of property overlays for abstracting. They

can be developed into maps for right-of-way acquisition, construction, and final inventory records. Any quantity of prints can be obtained in a standard black-and-white print machine.

6. Preliminary Preparations for Obtaining Special Right-of-Way Permits

Now preliminary maps are on hand. Preliminary reconnaissance is complete. Photography is started. Time is available to take initial steps toward obtaining special permits from town and municipal governments, railroads, drainage districts, etc. These agencies must be contacted early. Failure to make application early may result in costly construction delays. These preliminary steps should be taken:

(a) Jurisdiction of waterways must be established. Regulations governing crossings of government owned or controlled waterways and lands must be ascertained and followed. Instructions for preparation of forms of application and exhibits are specific. Compliance requires extensive preparation of application forms, surveys, and mapping. Crossing surveys and mapping should be completed early.

(b) Jurisdiction over Dominion and Federal highway crossings rests with the Provincial or State Highway Department. An engineer should be charged with the duty of consulting with the Highway Department to ascertain the exact regulations governing construction, inspection and preparation of crossing drawings, and applications for opening. If regulations are understood and complied with exactly, crossing permits will be quickly and automatically granted, and crossing surveys need not be completed in advance of the regular alignment survey. Delay in granting permits results only from failure to furnish complete information. To eliminate delays, survey instructions for each crossing should be issued to survey crews. Crossing drawings should be prepared upon receipt of field notes. Applications should be filed immediately.

(c) Jurisdiction over municipal and township roads may rest with the Provincial or State Highway Departments but if municipal highway departments or township boards have jurisdiction, they should be consulted. Since these departments seldom publish regulations, generally they should be approached with highway maps denoting the proposed pipeline location, and with forms of permits ready for signature.

(d) Regulations governing railroad crossing construction have been prepared by the Railway Engineering Association, but do not satisfy all requirements of every railroad. Each railroad company has its own requirements governing construction, preparation of forms of application, and crossing drawings. Specific instructions must be obtained from the office of the nearest division engineer, and complied with exactly. Processing of application takes 30 to 60 days, even when complete information is furnished. Consequently, it is frequently advisable to survey and map railroad crossings prior to the regular alignment survey and apply for crossing permits immediately.

(e) Jurisdiction over irrigation or drainage ditches and canals frequently rests with the local government or a private corporation. Either body may have specific regulations governing pipeline crossings. Requirements for construction and filing of applications should be determined early to avoid unexpected delays later.

7. Detailed Ground Reconnaissance

A very detailed ground reconnaissance should be started when photographs are available and prior to commencing surveys or right-of-way acquisition. An experienced location engineer scouts in the field, working with contact prints and a stereoscope, quadrangle and highway strip maps, and ownership maps. He can pinpoint an exact route on these maps at a rate of approximately 20 to 50 miles a day. The location he selects and delineates on photographs and maps will be so precise that surveyors can follow it with little deviation, and right-of-way agents can option or purchase rights-of-way using accurate roddage scaled from these photographs and maps. As the location engineer progresses, he should complete the maps and photographs for abstractors and surveyors so they can begin work immediately.

The logical order of the location engineer's work is as follows:

(a) Plot the line selected by preliminary reconnaissance on the contact prints, mosaics and other maps. Sectionalize and label all photographs.

(b) Stereoscope all contact prints, studying the terrain to determine the best slopes, stream crossings, etc. He should select the shortest route consistent with good construction and maintenance. This will be the most economical route.

(c) Examine all questionable locations on the ground. Highway crossings, railroad crossings, river crossings, ditches, banks, woodland areas, and heavily settled areas should always be observed on the ground. Locations across areas where it is apparent that right-of-way costs will be prohibitive should be eliminated.

(d) Revise the route on the maps and photographs by making the changes predicated by the ground examination, always maintaining the shortest route possible within the limits of good construction practice.

(e) Prepare and furnish sectionalized abstract overlays or photographic linen mosaics to abstractor. Furnish surveyors with one set of contact prints and a stereoscope, highway and quadrangle strip maps, and ownership maps, with the final line shown thereon.

8. Preparation of Abstract and Acquisition Maps

Abstractors should be furnished a large scale sectionalized map along the route of the line as selected by reconnaissance. On this map the abstractors can plot the description from each abstract or title search and assure themselves of continuous coverage along the line. The convenient scale for such a map is one inch equals 1000 feet since this is the scale that will be used for mapping throughout the project. Section lines, quarter lines and township lines, roads, railroads, streams, and towns should be shown and identified on the map as a guide to abstracting. The abstractor should identify each parcel with the owners name and a right-of-way number. Right-of-way numbers should be consecutive progressively down the line.

To insure reasonable accuracy when preparing these preliminary abstract maps, land measurements can be obtained in one of three ways: (1) by scaling from Quadrangle sheets of original township survey plats; (2) by making an overlay of ratioed photographic mosaics of the scale, one inch equals 1000 feet; (3) or, preferably, by using photographic mosaics on linen.

Completed abstract maps of the type described above are particularly adaptable as acquisition maps. Roddage can be scaled accurately from them. Landowners, who are universally interested in the route proposed across their lands, can be shown the proposed line on the map. If photographic maps are used, their value as acquisition maps is enhanced because the landowner can be shown an actual picture of his property and the proposed line. Also, acquisition costs are considerably less when the

right-of-way agent travels and buys by picture. The primary value of such an abstract map results from the fact that plotting descriptions continuously on a scale map eliminates essentially all possibility of missing properties and therefore provides an accurate method of proving continuous right-of-way.

9. Abstracting

The abstract for most pipeline work need be no more than a limited title search. However, in parts of the country where real estate values are high, a certified insured abstract may be required by legal counsel of the financial backers. The normal limited title search requires determination only of the current record owner and outstanding mortgages, judgments, or other liens. The abstractor should show all conveyances within the period of the search and obtain the land description. The decision as to whether a local abstractor or owner's agent should do the searching, will depend on cost, the allowable time, and the condition of the court house or abstractor's records.

10. Right-of-Way Acquisition

Right-of-way buyers should have three objectives:

(1) To establish good relations with landowners along the line. Good personal relations and fair dealings will assure the operating company of trouble-free association throughout the operating life of the line. Acquiring subsequent rights to maintain or loop the system will be less costly.

(2) To acquire the necessary rights for a reasonable and fair price. Each buyer will have his own method of approaching a landowner. Any method is satisfactory if the right-of-way is secured at a reasonable price, and relations are good as stated in Paragraph (1) above. The order and speed of buying are characteristics of the job. On most projects where construction is imminent, the limits of construction spreads should be established and right-of-way should be purchased progressively in advance of the movement of construction. If time permits, low-priced right-of-way should be purchased first and buying should progress toward higher priced right-of-way. However, it is imperative that right-of-way in the vicinity of communities and adjacent to large stream crossings, stations and terminals, where the pipeline location is fixed, should be purchased first. This will eliminate the possibility of major route changes, or the necessity of abandoning right-of-way already purchased if the right-of-way at these fixed points cannot be bought at an acceptable price.

(3) To be thorough and accurate when preparing the executing instruments. To avoid costly errors, all right-of-way forms should be prepared and checked thoroughly before being issued to buyers. Descriptions should be plotted and checked by the mapping department. Each buyer should be required to report daily in writing all details of expenditures and a history of owner contacts. Continuous daily cost records should be kept so that supervisors are always currently aware of expenditures. Individual owner records and a continuous recap of Costs are essential. Progress records are essential Overlay sheets, colored to indicate right-of-way acquired, should be kept current.

Right-of-way buyers should furnish the acquisition agent with a title search, a completed form of easement ready for signature, forms of tenant consent, a route map for travel, a draft book, and a print of a property overlay map or photographic linen abstract map showing properties as abstracted. If laws for notarization require that signatures be witnessed in person, a notary should travel with each acquisition agent. A notary selected because of wide acquaintance and good standing in the community, is generally a real asset to a buyer. His introduction to owners and an occasional statement in favor of the pipeline, can greatly hasten acquisition.

11. Location Survey

The duties of the location survey crew in general are to (a) stake the line for construction; (b) make an accurate traverse of the line; (c) obtain topographic, soil, and crop information; (d) locate and plus all property lines and tie in all property corners; and (e) make crossing surveys for design and permit purposes. If the reconnaissance was thorough, and the line selected by reconnaissance is accurately plotted on maps and photographs furnished the survey crew, the survey crew can devote its time to making a complete and accurate survey. However, additional reconnaissance may be required. Therefore, experienced pipeline location party chiefs are essential if the line is to be surveyed along the shortest, most economical location concurrent with good construction and maintenance practices. Their notes must be complete, neat and readable.

The survey crew should be furnished with right-of-way acquisition maps showing complete ownership information, quadrangle sheets, a route map, a set of photographic contact prints, and a photographic mosaic with the line selected by reconnaissance delineated on each.

12. Mapping

Mapping, in general, includes preparation of (a) highway, railroad, and stream crossing drawings for permit and design purposes; (b) alignment sheets for construction; and (c) final inventory alignment sheets. The information shown on maps should include the following:

(a) The pipeline traverse--showing courses and distances, to establish the exact location for construction, maintenance, and operations. The traverse also establishes the exact length of line for volume and flow calculations.

(b) Topographic features--showing locations of roads, streams, ditches, railroads, power lines, telephone lines, and buildings, towns, etc., for construction, maintenance and operations.

(c) Ground cover--showing cultivation, timber, brush, marsh, etc., for construction, maintenance, and settlement of damages.

(d) Soil--showing soil types, rock, marshes, etc., for construction and maintenance.

(e) Property information--showing ownership, right of-way numbers, property boundaries, corner ties, roddage, etc., for right-of-way acquisition and rights-of-way operations.

(f) Profile--showing continuous elevations for purposes of flow calculations. Exact elevations of critical points such as hills, valleys, streams, highways, railroads, etc., should be shown. A photographic alignment sheet, an actual picture of the right-of-way, has exceptional utility. It is time-saving when used as a travel map in the field or as a reference map in the office. Operating costs are reduced when it is used as a right-of-way construction and operating map.

The careful and accurate execution of this mapping procedure will facilitate registration with and approval by Provincial and State authorities. The Provincial and State authorities should be consulted frequently during all phases of the surveying and mapping work to insure compliance with all governing requirements, resulting in the elimination of costly delays in securing the necessary approval and registration.

13. Inventory Survey

An inventory survey is run after the pipeline is laid. If the preliminary location survey is thorough and accurate, as recommended in this article, the inventory survey need be only an inventory chainage of the pipeline and appurtenances. An inventory crew, consisting preferably of two or three surveyors familiar with the location surveys, should make the inventory. Installations should be referenced to the original survey stationing for addition to the alignment sheets. In general the installations to be inventoried will be:

(a) Pipe by size, type and weight
(b) Coating materials by type and manufacture
(c) Valves by size, type and manufacture
(d) River clamps by type and weight
(e) Cathodic protection leads by type and manufacture
(f) Rock padding by type
(g) Casing pipe by size type and manufacture
(h) Casing vents by size

14. Final Inventory Mapping

Using the construction alignment sheet as a base map, the final inventory map should be developed on linen in ink for permanence. The as-built inventory obtained by inventory chainage must be shown in its stationed location and listed in a Bill of Materials.

Pipeline maps, because they are used throughout the life of the line as operating, maintenance and right-of-way maps, require special skill during preparation.

15. Damage Settlement

The public relations aspect of right-of-way work must be emphasized during construction. A right-of-way agent should be assigned each construction spread. His duties should be (a) to advise landowners of the approach of construction in time for them to repasture stock and harvest marketable or usable crops; (b) to protect the interests of the landowner and consequently the pipeline owner from unnecessary damage to land, crops, roads, fences, etc., by construction crews; (c) to see that the clean-up is proper and complete; and (d) to pay reasonable and fair amounts for damages, assisted by damage measurements from the inventory surveyors.

It is apparent in this article that surveys, mapping and right-of-way must be closely coordinated. And, also, that an established, working organization staffed with experienced pipeline personnel, specializing in these services and familiar with proper procedures, is best qualified to perform this work on an accelerated schedule.